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A FACTOR ANALYTIC INVESTIGATION OF BRAIN DAMAGE TESTS WITH COMPARISONS OVER AGE

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a dissertation entitled "A Factor Analytic Investigation of Brain Damage Tests with Comparisons Over Age", submitted by Marion Steve Aftanas in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

ABSTRACT

This study investigated the factorial composition of brain damage tests selected on the basis of a comprehensive review of the test literature. The tests were administered to 100 normal persons between the ages of 16 and 70. Thirty-five variables were included in all the analyses.

Three separate analyses were performed. The first involved an analysis of the tests for the entire age range tested. This analysis concerned the determination of the factorial composition of the brain damage tests selected. Alpha factor analysis was employed with an initial rotation using the Varimax analytic criterion followed by a Promax oblique rotation. Twelve factors were retained for rotation but only three of these could be interpreted. The first three factors were designated as Perceptual Organization, Perceptual-Motor Speed, and Perceptual Resolution. The results of this analysis suggested that although the dimensionality of the brain damage test battery is relatively complex, the majority of the tests discriminate on the basis of a few dimensions, at least for normal persons.

The second analysis consisted of a test for factorial invariance for the data obtained in the 16-35 and 36-70 age groups. The Varimax solutions for the two age groups were selected for the invariance analysis. The results indicated a lack of relationship between the factors extracted. This result emphasized

the importance of systematic studies of factorial test composition over different populations. Such studies would have important implications for psychometric evaluations, and theoretical conclusions based on ontogenetic changes of test scores.

The third analysis involved the determination of factor scores for each individual on the twelve factors extracted in the 16-70 age group analysis. An analysis of the factor scores as a function of age indicated a significant decline for two of the factors, Perceptual-Motor Speed and Perceptual Resolution. This finding, that some of the factor scores varied systematically with age while others did not, was discussed in terms of the possibility that certain of the tests would be psychometrically more efficient in differential diagnosis of brain damage in the older person.

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INTRODUCTION

Statement of the Problem

The purpose of this study is to determine the factor structures for a sample of tests of brain damage administered to normal populations between the ages of 16 and 70. The study is concerned with three aspects of the factor solutions. The first is intended to evaluate the implicit psychometric assumption that the abilities sampled by a test, or series of tests, are ontogenetically constant. Evidence concerning this assumption should be obtained when the factor solutions determined for different age groups are submitted to invariance analysis. A high index of invariance would suggest a high degree of similarity between the factors, and hence the abilities sampled by the tests.

The second aspect will be concerned with the interpretation of the factors determined for the tests included. The tests have been selected on the basis of a comprehensive review of the brain damage test literature. The factor solution for the entire age range sampled should indicate the factorial composition of these tests. This analysis is intended to examine the scope of the tests presently being used for psychometric evaluation of human brain damage.

The third analysis is intended to explore the possibility of selective ontogenetic changes of the functional unities isolated in the factor analysis. Several studies have shown that factor pure

tests decline differentially as a function of age (Schaie, Rosenthal, and Perlman, 1953; Bilash, and Zubek, 1960). The present study will investigate possible changes in factor scores when they are plotted for the different age groups. The factor solution based on the entire sample will be used for this analysis. The results should suggest those tests that are psychometrically most efficient for the different age groups. By a psychometrically efficient test is meant one which discriminates between differently constituted groups. A psychometrically efficient brain damage test would be one which discriminates between brain damaged and normal persons. If the results indicated that factor scores did not decline as a function of age it would seem reasonable that a test with a high loading on that factor would be psychometrically efficient within the entire age range tested. A test loading a factor that did show decline in terms of factor scores, however, would not be efficient as an indicator of brain damage since a low test score could be attributed to the aging process.

Theoretical Considerations

An often quoted definition of intelligence within psychology has been that it is that which intelligence tests measure (Boring, 1923). One of the problems involved with such a definition has received very little empirical attention. The intelligence test may be a measure of different degrees of intellectual functioning in different sub-populations. One consequence of this possibility is

that the intelligence test would be valid for one only of these sub-populations; that is, that population for which sources of variation on the test are solely attributable to intellectual activity as implicitly or explicitly defined in the construction of the test.

The possibility that a test may be valid for some sub-populations but not for others exists not only for intelligence tests but also for any test which purports to measure some form of ability. The discussion to follow will be concentrated on intelligence tests, however, since a great deal of information concerning the problem under discussion is available in this area. It seems likely that similar considerations are applicable to the brain damage tests used in this investigation.

One of the criteria used for selecting items for an intelligence test has been that they represent an increasing scale of difficulty (Wechsler, 1958). An analysis of homogeneity or internal consistency ensures further that the test, or sub-test, measures intelligence consistently. If the test measures the same things in various sub-populations, then a higher or lower score would reflect increasing or decreasing degrees of intellectual activity for these sub-populations. This would be a necessary consequence of the definition provided in the construction of the test.

A consistent finding in ontogenetic comparisons is that intellectual activity, as measured by a particular intelligence test, increases to a certain age, remains relatively constant for a

period of years, and then decreases in a positively accelerating fashion (Doppelt and Wallace, 1955). The conclusions based on these findings have been criticized from a number of different viewpoints. Perhaps the most repeated criticism has been that the cross-sectional approach is inappropriate and only longitudinal studies could provide adequate descriptions of intellectual change. The cross-sectional method in ontogenetic research involves testing different samples at each of several age levels, while the longitudinal approach means testing the same persons at successive stages of the life span. It has been claimed that the intelligence tests are biased in that the intellectual behavior sampled is more readily available to the younger person in the present schooling system than to older persons who obtained less formal education in a different era. Results obtained from cross-sectional studies would, therefore, not only introduce errors of sampling but also reflect qualitative and quantitative differences in formal education and cultural experiences. The latter part of this criticism may have been true for earlier studies than it is today since the educational level of the older person tested is increasing (Anastasi, 1956).

Another criticism concerning particularly the decline of intellectual functioning in adulthood, has been that the present intelligence tests emphasize speed to the detriment of older persons performing on the tests (Lorge, 1936). The question arises as to whether obvious differences in perceptual and motor performance

should result in the assignment of lower intelligence scores and hence the interpretation that intellectual activity declines in adulthood. When the results of unspeeded administration of intelligence tests are compared with younger and older groups, the results present some apparent ambiguities. Miles (1934) found that the decline evident with the Otis Intelligence Test was less pronounced when the test was administered under no time limit conditions. Christian and Paterson (1936) reported a study involving a timed vocabulary test administered to 4 different age groups. They found that total scores declined as a function of age but that when only the first items were analyzed the 60-69 year group obtained the largest mean number of correct items. On the other hand, Doppelt and Wallace (1955) report only very slight increases on five subtests of the WAIS for subjects between the ages of 60-64 and 70-74 when they were allowed to complete the tests following the normal timed administration. Wechsler (1958) has concluded that the older person is not critically handicapped by the speed factor on the Wechsler Adult Intelligence Scale. The available evidence suggests, however, that part of the decline found in psychometric intelligence in adult samples is due to the emphasis on timed tests and speed credits.

One further criticism of the psychometric definition of intelligence as it relates to adults and older persons has recently been explicitly formulated by Jones (1959), and Birren (1964). They

have questioned the validity of the unreserved decline of intellectual activity as a function of age on the basis of the content of the widely used intelligence tests. Jones has presented some evidence which suggests a changing mental organization as a function of age. He argues that:

> "Where a composite test is used, based on a sampling theory of intelligence, it is obvious that an age curve, although based on the same items throughout, will necessarily represent somewhat different things at different ages. The test is only superficially the same, since its nature as a measuring instrument will vary according to the organization of intellect and also according to many non-intellectual factors which vary with age." (Jones, 1959, p. 721).

Birren (1964) has argued that an adequate criterion for the validity of the adult intelligence tests is not readily available. He notes that "the pattern of mental abilities change with age," which leads "to the issue of differential weighting of intelligence test results; e.g., should greater weight be given to the increments in scores or to the few tests showing decrements?" Birren suggests that the criterion of school success is a valid one for children or young adults but that the same conditions should not necessarily be extended for the content of adult tests. He presents the argument that "If 'social intelligence' is to be emphasized as a criterion of adult intelligence, then the measures of verbal comprehension might be weighted more heavily than measures of perceptual function." (Birren, 1964, p. 182). If such were the case then it would be evident that the intellectual ability curve plotted as a function of age would be considerably different.

Of the various criticisms of the theoretical interpretation of intellectual decline these would appear to be the most crucial. What is being emphasized in the analysis of Jones and Birren is that a particular psychometric definition of intelligence which may be applicable to younger persons is inadequate for adults and older groups. There can be no question that intellectual functions are changing as a function of age. But what these changes are in relation to psychometric models of test behavior has not been fully investigated.

The compensatory model (Coombs, 1964), in one form or another, has been assumed by psychometric theorists. This model states that a specific score on a particular test can be achieved by an additive combination of correct responses to any of the items on the test. On a test with 35 items of equal weight a score of 20 would be attained when any 20 of the 35 items are correctly answered. Similarly, a score on a test with more than one sub-test can be obtained by any weighted combination of scores on the sub-tests as well as any items within a particular sub-test. This model has recently been explicated by Royce (1965) in factor analytic terms. Royce has stated that when the same intelligence score is obtained by two individuals it might be concluded that they are intellectually similar. An analysis of the factorial composition of these scores, however, would reveal a difference in the types of intellectual abilities used by each individual to achieve that score.

The compensatory model of particular interest to this discussion is what Coombs (1964) has referred to as the stimulus

compensatory model. As applied to psychometric theory this model suggests that successful completion of a specific item on a test requires some combination of abilities. The item circumscribes the type of abilities required. The general outline of this model would appear to be applicable to a wide variety of test situations. In cases where variation in test performance reflects variation in the abilities or constructs that the test purports to measure, it would be legitimate to attribute test scores to a combination of these abilities. The possibility exists, however, that some part of the variation can be attributed to sources other than those of primary interest. When variability from such sources are substantial, in terms of contributions to the score obtained, the appropriateness of the model and the adequacy of the test would have to be questioned.

The simple compensatory model applied to an intelligence test such as the WAIS may be misleading. It may be true that under certain circumstances the compensatory model is applicable because some part of the abilities required is relatively constant in the population under consideration. To take an extreme example, for certain segments of the English speaking population the American standardization of the WAIS may be compensatory since sources of variability can be attributed to the abilities being measured. For non-English speaking persons, however, the test becomes conjunctive. A certain degree of facility with the English language is assumed before the compensatory models are appropriate. Similarly, for a specific age

group a sub-test of the WAIS may be compensatory because one of the abilities required is constant throughout that age group. For another age group, however, the sub-test may be conjunctive since the ability that was constant at one age is now variable. It becomes necessary for the individual to exceed a certain level on that ability before the sub-test becomes compensatory and comparable to the age group in which this ability was constant. Under such an analysis the validity of administering a test which is assumed to be compensatory to a population for whom the test is conjunctive should be seriously questioned.

In terms of the theoretical interpretation of intellectual change as a function of age, this analysis has some interesting implications. It would seem that one of the most important questions that must be answered before intellectual changes can be described concerns the isolation of relevant variables for the different age groups. In order to determine whether the compensatory model applicable to one age group is also legitimate for another it is necessary to delimit the organization of abilities in the various age groups. Ferguson (1965) has stated in a developmental context that "a model for the organization of human abilities must deal with the developing and changing structure of abilities.....and must go beyond a descriptive statement of the organization of abilities at a particular point in time." (Ferguson, 1965, p. 48). A delimitation of the organization of abilities in the various age groups would be

important not only from a psychometric, but also from a theoretical point of view, insofar as the changing structure of intellect is concerned.

The factor analytic method would seem to be appropriate for evaluating the possibilities of changes existing in the organization of abilities for different age groups. The method is used to analyze correlations determined between various measures of abilities, and delimits the common sources of variation found in these measures. The method determines not only the dimensionality of the observed variation on the tests but also the degree to which variation on a particular test can be accounted for by the different dimensions.

Three aspects of the factor solutions for different age groups could be investigated to determine whether or not differences in the structure or level of functioning are evident. The first would involve an invariance comparison between the factor solutions for different age groups. This comparison should indicate the degree of relationship existing between the common sources of variation observed in the groups. Secondly, an analysis of the dimensionality of the different solutions should provide evidence concerning possible differences in the complexity of the tests for the groups. If the degree of relationship between the solutions is high and the dimensionality is the same for the groups then it would seem evident that a compensatory model could be appropriate. Thirdly, a complete

factor analysis could be used to derive a factor score for each individual on each of the factors, thereby providing an index for comparing factor scores at different age levels.

Empirical Findings

The factor analytic model has been used by a number of investigators to explore the underlying deminsionality of intelligence test behavior for different age groups. Much of the work has been concentrated on one instrument and its variations; the Wechsler-Bellevue Intelligence Scale, the Wechsler Adult Intelligence Scale, and the Wechsler Intelligence Scale for Children. What is perhaps more surprising is that the majority of these studies used the data from the original standardization samples. The studies differ on a number of methodological points, however, which makes direct comparison somewhat difficult. They differ also in respect to the types of information provided and the types of conclusions drawn. None of the studies provides an analysis of the data in terms of factor scores. These studies will be reviewed in terms of the type of comparisons that have been made using the factor analytic model.

Balinksy (1941) has reported a study in which he factor-analyzed the scores of nine of the Wechsler-Bellevue Intelligence Scale sub-tests, for six age groups: 9, 12, 15, 25-29, 35-44, and 50-59 years. The Similarities sub-test was excluded from the analysis because complete data were not available, and the Vocabulary sub-test was also not used since it was introduced as an alternate

test some time after the standardization had been initiated. Comparison with subsequent analyses of this test becomes difficult as a result. Balinsky used Thurstone's centroid technique for the separate analysis of each of the age groups and rotated orthogonally using the single-plane graphical method described by Guilford (1936).

For the comparison of the organization of intellect at the various age levels Balinsky offers various types of evidence. The major findings from the point of view of the present analysis are that differences for the age groups were evident in the number of factors extracted, the designation of the factors, and the factorial composition of the tests. Balinsky reported an increase in the number of factors extracted between the 9 and the 25-29 year group and then a decrease in the 35-44 and 50-59 year groups. On the basis of these results he suggests that there is a "tendency toward greater specialization from age 9 to age 25-29, and thereafter an apparent re-organization to a complexity which can be described as flexible." (Balinsky, 1941, p. 231.) Before this conclusion can be accepted an analysis of the criterion used to determine the adequacy of the extraction for the various groups is necessary. Balinsky used what seems to be an arbitrary criterion of .316 to evaluate the individual loadings for each factor. If at least one test loading was as high or higher than the criterion in the centroid analysis then the factor was retained for the rotation. The inadequacy of this criterion is illustrated in the analysis of the data for the 35-44 year group where four factors were extracted with only

two of these being acceptable in terms of the criterion. Balinsky retained the first three factors for rotation, in spite of the fact that the fourth factor accounted for a larger percentage of the variance, and found that the factor was identified by four tests with loadings greater than .30. The possibility exists that had Balinsky used a criterion based on the entire matrix the results would have been somewhat different.

Balinsky also reports changes in the designation or complexity of the factors. For age nine, seven of the nine tests load highly on Factor A while in the 25-29 age group one doublet and two triplet factors (Thurstone, 1947) were interpreted. This trend is reversed in the older age groups. In the 50-59 age group six of the nine tests load highly on Factor A, which Balinsky has interpreted as a g factor. These findings suggest an increasing differentiation of ability up to the 25-29 age group with subsequent constriction or re-organization. It would appear that the very young and the older person are using fewer abilities or their abilities are more closely integrated in performance on these sub-tests.

One other finding of interest was that the same factors did not appear in all age groups studied. The two factors most consistently found were Verbal and Performance. The Performance Factor was not found in the 9 year group and the Verbal Factor did not appear in the 50-59 year group. What was interpreted as a general factor was found only in 9 and 50-59 year groups. Balinsky's Memory Factor

appeared in the 25-29 and 35-44 year groups only. Each of four other factors were found to be specific to a particular age group. The evidence from Balinsky's study seems to suggest that different abilities are being utilized for performance on the Wechsler by persons of different ages.

Birren (1952) has reported a factor analytic study of the Wechsler-Bellevue Intelligence Scale which supplements the age range studied by Balinsky. Birren analyzed scores obtained on all 11 subtests of the Wechsler administered to 99 subjects between the ages of 60 and 74. The centroid analysis was used, with rotation to oblique simple structure. Three interpretable factors were isolated and a fourth was reported even though only one test had a loading above .30 for this factor. These three factors were named Verbal Comprehension, Closure, and Rote Memory. It should be noted that the correlation between the first two primary vectors was +.72 suggesting a very close relationship between them.

Birren's Closure and Memory factors are similar to Balinsky's Performance and Reasoning factors respectively. Direct comparison is difficult, however, since Birren included two heavily verbal subtests which were not considered by Balinsky. One further point of interest should be noted. Birren reported a factor matrix in which the first factor was placed orthogonal to the remaining three. In this matrix all the tests loaded substantially on the first factor which Birren calls Stored Information. In fact, the first factor in

this analysis accounts for approximately 75 percent of the extracted (common) variance. This finding, in addition to the observed high correlation between the first two factors in the oblique solution, tends to confirm and extend Balinsky's finding that there is a decreasing specificity in the older age groups. This suggestion should be qualified in terms of the measuring instrument since it may well be true that the Wechsler is measuring only some part of intellectual ability in the older age groups.

A study reported by Cohen (1956, 1957) presents perhaps the most striking illustration of the changing organization of intelligence in older age groups. Cohen factor analyzed the intercorrelation of the 11 sub-tests of the Wechsler Adult Intelligence Scale (WAIS) administered to the original standardization sample (Wechsler, 1955). The four age groups were: 18-19 (N = 200), 25-34 (N = 300), 45-54 (N = 300) and the Kansas City old age sample of ages 60-over (N = 352). Cohen used the centroid method of analysis and Saunder's criterion for determining the sufficiency of the factoring procedure. The extracted factors were rotated to oblique simple structure with positive manifold. Cohen reported five factors for all groups except the 60-over 75 group in which only four were extracted. A loading greater than .20 was accepted as significant for purposes of interpretation.

Cohen interpreted three factors at each of the age levels studied. These were named Verbal Comprehension, Perceptual

Organization, and Memory respectively. Two other factors were extracted in all groups except the 60-over 75 group. These factors appeared as doublets and unique factors in the different groups. The Picture Completion sub-test consistently loaded factor D for all groups and Digit Symbol loaded factor E for all but the 60-over 75 group. No consistency was observed in the other tests loading these factors.

Several points of interest can be noted in Cohen's factor analyses. The first is that the number of factors extracted was not the same for the different age groups, suggesting that the factor complexity of the WAIS decreased for the oldest age group studied. The second finding of interest is that the Memory Factor accounted for an increased proportion of common variance in the 60-over 75 group. This factor accounted for substantial portions of variance in sub-tests which loaded only the Verbal Comprehension Factor in the other groups. One other finding of importance concerns Cohen's second order analysis of the oblique factors. This analysis yielded one second order factor which was interpreted as present general intellectual ability or G. Comparison across age groups indicated that the variance attributable to the G factor was fairly constant up to the oldest age group where a substantial decrease was evident. Cohen concluded that for "the 60-over 75 group, the Memory Factor undergoes a sharp increase in variance at the cost of the general factor." (Cohen, 1957, p. 290).

A more recent report (Berger, Bernstein, Klein, Cohen, and Lucas, 1964) incorporated the same sample but used the Biquartimin criterion for oblique rotation, and Burt's index of factor similarity in comparing the factor solutions for the different age groups. Berger et al., rotated four factors in each of the four age groups represented. The criterion the authors used for determining the sufficiency of the factoring procedure was based on the rotational method. They report that the "biquartimin procedure results in a 'collapse' of later factor dimensions when smaller factors are included for rotation." (Berger et al., 1964, p. 200). Factors were extracted until rotation resulted in the "collapse" of a dimension.

Although the number of factors extracted presumably remained constant across age groups other comparisons indicated differences. Burt's index of factor similarity suggested substantial uniformity of factor loadings for only the first two factors. One exception to this was found in the comparison of factor three for the 25-34 and 45-54 year groups. For these groups factor three was identified as the Memory Factor found by Cohen (1957) in his analysis of the same data. In the 18-19 and 60-over 70 age groups the Memory Factor could not be identified as such. Berger et al. conjectured that for these two groups the Memory Factor "coalesced" with the Verbal Factor and appeared as Factor 1.

The essential difference reported by Berger et al. for the age groups would appear to concern the distribution of variance for

the separate sub-tests. The Arithmetic and Digit Span sub-tests load Factor 1 for the 18-19 and 60-over 75 groups, but designate a separate Memory Factor in the other groups. The Digit Symbol sub-test does not load any single factor consistently. Surprisingly, part of this sub-test's variance in the 18-19 age group was accounted for by what was identified as the Verbal Factor. Other sub-tests which did not load factors consistently across age groups were Picture Completion and Picture Arrangement. These findings tend to substantiate the interpretation that a test may not measure the same thing at different age levels, since the sources of variability are not constant in ontogenetic comparisons.

One other factor analytic study of changes in intellect with age has been reported by Green and Berkowitz (1964). This study included determination of centroids and varimax rotation for data obtained from 1283 residents of a Veterans Administration Domiciliary on the Wechsler-Bellevue test. The highest column entries in the R matrix were used as communality estimates and these were not iterated. The factoring procedure was continued until the product of the two highest loadings for a centroid was less than .04.

The results reported by Green and Berkowitz appear to be consistent with different aspects of the results found in previous studies. The Green and Berkowitz study involved the extraction of a decreasing number of factors as a function of age. This finding is consonant particularly with Balinsky's analysis which was also based

on the Wechsler-Bellevue Intelligence Scale. The exact number of factors extracted for comparable age groups differed, however, in the two studies. Green and Berkowitz found also that the factor interpreted as Memory was evident in all but the under 29 age group. The absence of this factor as a source of common variance was noted in both the Balinsky (1941) and the Berger et al. (1964) studies for younger groups.

One other finding in the Green and Berkowitz study was evident also in all other studies reported. The test complexities in terms of the factors extracted differed for the various age groups studied. For all but one of the sub-tests in the Green and Berkowitz study, one of the first two factors was found to account for part of the common variance consistently in the ontogenetic comparisons. The one exception to this observation was the Digit Span sub-test, for which no consistency in factor description was indicated over age groups. The variance observed on the Information and Vocabulary sub-tests was accounted for by a single factor (Factor 1) in all the age groups studied. For the balance of the sub-tests, however, the test complexity and factor description was found to differ over the age groups studied. The generality of this observation, at least for the WAIS and WBI, is evidenced by the fact that all of the studies concerned with this problem have indicated such differences.

The studies previously reported which have used the method

of comparing factor structures as a function of age have exclusively been concerned with Wechsler's tests of intelligence. The method, used, however, is a completely general one. The principle of determining whether the sources of variance are the same for different age groups would seem to be as important an area of study as the more generally accepted principles of reliability and validity. When reliability and validity coefficients have been determined for a series of tests in a particular standardization group there appears to be no hesitancy to use the test for psychometric evaluation in other age groups, even though the possibility exists that abilities irrelevant to the validity of the tests are being measured in these groups.

One group of tests that have not been studied extensively either in terms of the factor analytic model or from the point of view of possible ontogenetic changes in factor structure are tests of brain damage. Such a study of test results obtained from a normal population would be important for reasons other than that of evaluating the stability of factor structures over different age groups. A factor analytic study of the available brain damage tests would indicate the factorial composition of these tests and should at least suggest the bases of discrimination between brain damaged persons and normals.

A number of factor analytic studies of brain damage tests have been reported (Halstead, 1947; Jones and Wepman, 1961; Schuell, Jenkins, and Carroll, 1962; Coppinger, Bortner, and Saucer, 1963),

but they have been limited in terms of the tests selected for analysis. Perhaps the Halstead study (Halstead, 1947) comes closest to a comprehensive selection of brain damage tests, but even these are limited when compared with the large number of tests which have recently been reported to discriminate between brain damaged and normal individuals. Also, the interpretation of factors in the Halstead study was made difficult by the fact that very few of the tests had substanial projections on three of the four factors observed. The Jones and Wepman (1961) and Schuell, Jenkins, and Carroll (1962) studies were concerned with tests limited to specific types of evaluation. The measures of interest in these studies were directed at the determination of relevant dimensions of aphasic behavior. One further factor analytic study of brain damage tests has been reported. Coppinger, Bortner, and Saucer (1963) selected a variety of tests for analysis including personality tests and some of the more widely used tests of brain damage. The identification of factors in this study was to a large extent influenced by the inclusion of personality tests, such as the Minnesota Multiphasic Personality Inventory. As a result these findings have very limited generality insofar as the isolation of relevant dimensions of brain damage is concerned.

A recent review of all the brain damage test literature (Royce and Carran, 1964) has revealed a large variety of tests which have been found to discriminate between brain damaged and normal persons.

A factor analytic study of the more valid and reliable instruments would be important for determining the factorial composition of these tests. Such a study would indicate the extent to which the sources of variability are the same for these tests; at least when they are administered to normal populations.

The present study will be concerned with three separate factor analytic solutions. The first concerns a complete factor analysis of data obtained from individuals over a large age range on a variety of brain damage tests. This analysis will be used to determine the factorial composition of these tests. The second analysis will be concerned with a comparison of factor structures for different age groups. This analysis should indicate the degree of similarity between factors extracted for these different age groups. One other analysis will be applied to determine individual factor scores as a function of age. The results should suggest those tests that are psychometrically most efficient for the different age groups. If the results indicated that factor scores did not decline as a function of age then a test with a high loading on that factor should be psychometrically efficient within the entire age range tested.

DESCRIPTION OF THE TESTS

The tests used in this study were compiled for a brain damage project on the basis of an exhaustive search through the literature for tests which purported to discriminate between brain lesion groups and normals. The initial research and selection of these tests was made by J. N. Dardick under the direction of J. R. Royce of the Department of Psychology, University of Alberta. A review of approximately 300 titles resulted in an initial list of 75 tests. Twenty-nine of these tests were chosen for inclusion in the battery on the basis of the following criteria: validity, reliability, objectivity of procedure and scoring, *a priori* factorial simplicity, low dependence on cultural variables, and diversity (Royce and Carran, 1964). Four of these twenty-nine tests were excluded at the outset or during testing for the following reasons: the Metamegethograph (Scott, 1962) and Continuous Performance (Rosvold et al., 1956) tests were not available when testing was begun, and the Face-Hand and Stimulus Generalization tests were eliminated during the early stages of testing because of lack of variability in observed scores in the normal population. The lack of variability might be expected for the Face-Hand Test (Bender et al., 1954) in a normal population but was not predicted for the Stimulus Generalization Test from the results of Mednick's (1955) study. The major references supporting the validity of each test are given in Table 1.

TABLE 1

The Complete Test Battery and the Primary

Validity Study for Each Test

	TEST	PRIMARY REFERENCE
1.	Coloured Progressive Matrices	Dils (1960)
2.	Proverbs	Elmore & Gorham (1957)
3.	Retinal Rivalry	Sappenfield & Ripke (1961)
4.	Modified Word Learning	Walton & Black (1957)
5.	Apparent Motion	Saucer & Deabler (1956)
6.	Organic Integrity	Tien (1960)
7.	Binaural Beats	Price et al. (1958)
8.	Grassi Accuracy	Grassi (1953)
9.	Grassi Time Credits	Grassi (1953)
10.	Symbol Gestalt	Stein (1962)
11.	C.F.F. Mean	Halstead (1947)
12.	C.F.F. Deviation	Halstead (1947)
13.	Porteus Maze(s)	Porteus (1959)
14.	Memory for Designs	Graham & Kendall (1946)
15.	Halstead Rhythm	Halstead (1947)
16.	Tactual Performance Latency	Halstead (1947)
17.	Tactual Performance Memory	Halstead (1947)
18.	Tactual Performance Localization	Halstead (1947)
19.	Trail Making Latency	Reitan (1955)
20.	Hooper Visual Organization	Hooper (1952)
21.	Halstead Speech Sounds	Halstead (1947)
22.	Halstead Category	Halstead (1947)
23.	Minnesota Percepto-Diagnostic	Fuller & Laird (1963)
24.	Grayson Perceptualization	Grayson (1954)
25.	Sound Localization Separation	Shankweiler (1961)
26.	Sound Localization--Localization	Shankweiler (1961)
27.	Purdue Pegboard Total	Costa et al. (1963)
28.	Purdue Pegboard Assemblies	Costa et al. (1963)
29.	Kahn Test-Symbolization	Kahn (1951)
30.	Kahn Test-Recall	Kahn (1951)
31.	Muller-Lyer Error	Jenkin & West (1959)
32.	Muller-Lyer Difference	Jenkin & West (1959)
33.	Reaction Time Simple	Benton & Blackburn (1959)
34.	Reaction Time Choice	Benton & Blackburn (1959)
35.	Age	

A description of the tests which were administered to all the subjects will now be given. In most cases the scoring systems suggested by the authors of the tests were used. For some tests the score assignment was reflected so that a high score could be associated with greater proficiency rather than the reverse. Any changes made and the reasons for such changes are indicated in the discussion of the test. Table 1 provides a complete list of the tests. Means and standard deviations of test scores for the different groups are given in Appendix A.

Test 1. The Coloured Progressive Matrices

The book form of the Coloured Progressive Matrices devised by Raven (1956) was used. The test consists of three subsets of test items increasing in difficulty which require the subject to select from six alternatives the design which completes a partially incomplete pattern. The test has been used extensively as a "culture-free" intelligence test (Anastasi, 1961), and is believed to be a good measure of Spearman's g factor. Studies on brain-damaged populations (Dils, 1960; Urmer et al., 1960) have reported significant difference scores when comparisons are made with normals. The test was included also as a possible reference variable, and for its low dependence on cultural variables (Royce and Carran, 1964). Procedures for administering and scoring this test have been outlined by Raven (1956). The score for this test is the total number of correct items.

Test 2. Proverbs Test

The multiple choice form of Gorham's (1956) Proverbs Test was used. This form consists of 40 proverbs with four alternate responses given for each. One of the alternatives presented represents an abstract explication of the proverb. The score for this test is the total number of abstract alternatives selected. Elmore and Gorham (1957) found that test results on this test discriminated between normal and organic groups.

Test 3. Retinal Rivalry

The Retinal Rivalry Test consists of a green and red card with opposing diagonal black lines presented to the S through a Brewster Stereoscope. A description of the apparatus and the instructions used has been presented by Sappenfield and Ripke (1961). The green and red sections of the card are viewed separately by each eye and the S is asked to report color or line changes. The score consists of the total number of color and/or line changes reported during two 30-second periods.

Test 4. Modified Word Learning Test

The Modified Word Learning Test involves the administration of the Terman-Merrill (Form L) Vocabulary Test and the Mill Hill Vocabulary Scale until the S is unable to provide the meanings for ten consecutive words. The actual test requires the S to memorize the meanings of the words missed after they have been presented verbally by the administrator. The ten words are repeated by the

administrator until the criterion has been reached. The criterion for successful performance on this test (Walton and Black, 1957) is that the subject provide the meanings for six of the ten words missed. The scoring system employed was identical to that reported by Walton and Black except that the score obtained was subtracted from 100 to provide a positive direction of measurement.

Test 5. Apparent Motion

The Apparent Motion Test consists of the familiar laboratory instrument made up of two alternating lights which, under certain conditions, appear to be moving back and forth. The apparatus was constructed from the descriptions provided by Saucer and Deabler (1956). Testing was initiated at a base rate of 2.5 flashes per second, which normally provides for good Beta Movement, and the rate was then increased in steps of 0.5 flashes until the _S_ reported Omega Movement. In Beta Movement a light seems to be moving back and forth between the two light sources, while for Omega Movement the two lights seem to be blinking on and off separately. The _S_'s score was the mean flash rate for Omega Movement over four separate trials.

Test 6. Organic Integrity Test

The Organic Integrity Test (Tien, 1960) consists of ten sets of three colored pictures. The pictures are incomplete insofar as they depict only parts of objects. This incompleteness assists in making definite identification of the objects difficult. Two of

the pictures are presented on one card. The third picture is similar in certain but different respects to both of the connected pictures. The _S_'s task is to choose that one of the connected pictures which seems to be most similar to the third picture. The responses are scored either for form or for color in terms of the dominant similarity to which the S responded. Tien (1960) provides some transformation values which are assigned all the form responses. The _S_'s score is the total of these values.

Test 7. Binaural Beats

This test involves the perception of the Binaural Beat phenomenon when two slightly different tones are presented separately to the two ears. The tones are generated by two independent Audio Frequency Oscillators. A detailed procedure and evidence for the diagnostic efficiency of this test has been presented by Price et al. (1958). Essentially, the test involves the presentation of a steady tone of 250 cycles per second in one ear and another tone varying from 200 to 300 cycles per second in the other. Four trials consisting of two ascending and two descending series are presented. The constant tone is alternately generated to the left and right ears. The score is the number of trials in which the beat phenomenon is reported.

Tests 8 and 9. The Grassi Block Substitution Test: Accuracy and Time Credits

The Grassi Block Substitution Test (Grassi, 1953) consists

of an adaptation of the Kohs Blocks in which the subject is asked to copy a series of designs using a set of four blocks. The designs are presented to the subject on blocks. The test involves the presentation of five different block designs under four different task instructions. Under one task instruction the S copies only the top of the blocks using the same colors. In the second he is asked to copy the top only but using different colors from those in the demonstration design. Under the last two task instructions the S copies all sides of the blocks employing the same and different colors respectively. Test number 8 represents an accuracy score; that is, the number of blocks that are correctly reproduced. The score for test 9 was the number of time credits obtained based on the credit system suggested by Grassi.

Test 10. Symbol Gestalt.

The Symbol Gestalt Test (Stein, 1962) is a timed task in which the S is asked to reproduce as rapidly as possible a series of symbols associated with different numbers. To a large extent the test is similar to the Digit Symbol sub-test of the Wechsler Adult Intelligence Scale. One difference is that the symbols in the Symbol Gestalt Test lack closure and balance. An important aspect in the marking of this test is whether or not lack of closure is maintained in the reproduction. The author suggests that organics tend to simplify the reproduced design by affecting closure and providing balance. The score for this test is the number of correct reproductions completed within the three minute time limit.

Tests 11 and 12. Critical Flicker Frequency: Mean and Deviation

The Critical Flicker apparatus consisted of a Strobotac (Stroboscopic Tachometer, Type 631 BC) mounted in a soundproofed box with a frosted glass opening. All but 1 millimeter of the frosted glass was blacked out with an opaque paint. The calibration was made directly from the Strobotac. Adjustments of frequency were made by the experimenter for six alternately ascending and descending trials. The _Ss_ were to report when fusion occurred for ascending trials and when flicker occurred for descending trials. One of the scores was the mean of the frequencies at which fusion was reported. The deviation score consisted of the mean absolute deviation of the six frequencies from the mean of these frequencies.

Test 13. Porteus Maze

The Vineland Revision of the Porteus Maze Test (Porteus, 1959) was used. The test consists of a series of mazes increasing in difficulty and standardized for children and adults. The scoring system suggested by Porteus was used in which one-half point is subtracted from the total possible for each maze that is not successfully negotiated. Successful performance requires that a pencil trace be made from start to finish without entry into a blind alley. Once a blind alley is entered the test sheet is taken away and a new maze for the same year is provided. Presumably successful performance requires planning a strategy and remembering the strategy until the exit is reached. The test is not timed.

Test 14. Memory-For-Designs

The Memory-For-Designs Test (Graham and Kendall, 1960) consists of 15 designs which are presented to the subject one at a time for 5 seconds, and which he must reproduce after the design has been taken away. The designs range from a simple equilateral triangle to a design similar to that used in the Stanford-Binet (Form L) at Year 9. The scoring system outlined by Graham and Kendall was reversed in this study so that a correctly reproduced design received a three score and points were subtracted for deviations.

Test 15. Halstead Rhythm

The Halstead Rhythm Test is a taped version of Seashore Rhythm Test used by Halstead (1947) in his battery of tests. The test consists of 30 paired rhythms which the subject must identify as being the same or different. The score obtained is the total number of correct identifications.

Tests 16, 17, and 18. Tactual Performance: Latency, Memory, and Localization.

The Tactual Performance Test is Halstead's (1947) adaptation of the Sequin-Goddard form board test. Specific procedures and instructions were provided by Dr. R. M. Reitan. In this test the subject is blindfolded before the board and blocks are brought into the test room. The S is allowed first to explore the space on the board tactually and is then asked to fit the ten blocks

into their proper places on the board. The S does this task with each hand separately and then using both hands. The latency score is the total time in seconds for the three trials. After the S completes the three trials the board is taken from the room, the blindfold is removed and he is asked to reproduce the blocks on a sheet of paper in terms of their proper locations on the board. Two scores are obtained from this part: a Memory score consisting of the total number of correct reproductions, and a Localization score comprised of the number of correctly placed reproductions. One difference between the board used by Halstead and that used in this study was pointed out only after testing had been completed. In this study the longer side of the retangular board was parallel to the testing surface, while in Halstead's study this side was perpendicular to this surface. The effect of this difference in test situations could not be determined.

Test 19. Trail Making Latency

The Trail Making Latency Test (Reitan, 1955) consists of two sheets of paper on which are a series of randomly placed circles containing numbers or letters. Part A of the test contains only numbers while Part B contains both numbers and letters. For each part the S is given a practice trial with a few circles on the reverse side of the test proper. In Part A the S is required to draw a line beginning at number one and connecting the circles in numerical order until number 25 is reached. For Part B the task becomes

more difficult insofar as S must alternately connect a number and a letter in sequence until the last circle is reached. The score for this test is the total time taken to complete Parts A and B.

Test 20. Hooper Visual Organization Test

In this test the S is required to name objects which have been cut up and rearranged on cards (Hooper, 1948). Thirty such cards with cut-up objects are presented and the score is the total number of correctly identified objects.

Test 21. Halstead Speech Sounds Test

This test was included in Halstead's (1947) battery of tests. The tape and detailed procedure and instructions were supplied by Dr. R. M. Reitan. The test consists of 60 nonsense syllable items presented verbally involving the digraph "ee". The subject is required to select the word just heard from a list of four variants which differ with respect to the beginning or ending consonants. The items are presented from a tape recorded by a male voice. The score for this test is the total number of correctly identified items.

Test 22. Halstead Category Test

This is another of the tests from Halstead's (1947) battery. The equipment, instructions, and procedures were supplied by Dr. R. M. Reitan. In this test 208 geometrical figures and designs are projected directly in front of S and he is asked to press the lever

which corresponds to the number suggested by these figures. The S is immediately reinforced by a chime for a right answer or a buzzer for a wrong answer when he presses the lever. The test consists of seven sub-tests of varying difficulty. The task is essentially one of concept attainment in which S tests various hypotheses until he has arrived at the correct principle. For example, in the third sub-test the S must learn which one of the four designs presented is most different from the others. The S then presses the lever corresponding to the location of this design. Six of the sub-tests require the S to attain a concept while the seventh involves items from the previously presented sub-tests. The S remembers the correct principle in order to make a correct response. The score for this test is the total number of correct responses for the seven sub-tests.

Test 23. Minnesota Percepto-Diagnostic Test

The Minnesota Percepto-Diagnostic Test (Fuller and Laird, 1963) consists of six gestalt designs which S copies directly from the presented cards. The designs and the blank sheet used for copying are placed perpendicular to the S. The scoring system is based on the degree of rotation from the perpendicular found in the S's reproductions. Any rotations less than 25 degrees are recorded as measured while larger rotations are assigned the maximum value 25. The score recorded for each S was the total rotation score for the six designs.

Test 24. Grayson Perceptualization Test

This test consists of two printed reading selections in which the spaces between and within the words are equal. When first viewed the page appears to contain a block of randomized letters. The S is required to separate the words with a pencil mark so that the words and sentences become meaningful. The score for this test is the number of words correctly separated within a specific time limit. Two different reading passages are timed separately. Although Grayson (1957) suggested that a two minute time limit be used for each passage, it was found in preliminary testing that many persons finished before this time. Because of this a one minute limit was imposed for each passage.

Tests 25 and 26. Sound Localization: Localization and Separation

The Sound Localization Test (Shankweiler, 1961) consists of a perimeter with track for a moveable sound source, and a chin rest. Three sound sources are mounted on the track. The test equipment and procedures were identical to those outlined by Shankweiler. For the Localization part of this test the S is required to point with a pencil to the source of a single sound. The score is the mean error in degrees of arc for the 24 trials. The Separation Test requires the S to determine whether the second of two sounds is to the right or to the left of the first. This discrimination is made to the left and right of the midline and to the left and right of the 60 degree position from the midline. The variable sound source is

positioned at 5, 10, 15, and 20 degrees from the standard. The trials are randomized with respect to side of midline, side of 60 degree standard, and degree distance from standard. The score for this test is the total of the highest errors in degrees for all positions of the standard.

Tests 27 and 28. Purdue Pegboard: Total and Assemblies

This is the familiar test of dexterity and coordination (Costa et al., 1963). The total score consists of the total number of pegs placed for the right and left hands plus the number of pairs placed with both hands. The Assembly score is the total number of assemblies completed within the one minute time limit.

Tests 29 and 30. Kahn Test: Symbolization and Recall.

The Kahn Test (Kahn, 1951) consists of a felt strip with 15 equally spaced segments consecutively numbered from one to fifteen and 16 object symbols of various colors. The S is asked to arrange 15 of the objects on the strip in any manner he wishes. Although S is asked to arrange the objects on the strip five times only two will be described since they formed the basis for the scores obtained. The symbolization score is obtained after the second arrangement when S is asked to indicate what each of the objects symbolizes to him. A score is assigned to each of these symbolizations on the basis of degree of abstractness as outlined by Kahn. The third arrangement forms the basis for the Recall score insofar as S is asked to arrange the objects exactly as he had them in the

previous trial. The Recall score is the total number of objects he has correctly replaced.

Tests 31 and 32. Muller-Lyer Illusion: Error and Difference

The apparatus for this test consists of a 23 centimeter white line with accompanying arrowheads. On one side of this figure is a variable line which ends in a featherhead. The reverse side of the slider containing the variable line is calibrated in millimeters and indicates both positive and negative deviations from objective equality (for a more detailed description of the apparatus and procedure see Jenkin and West, 1959). A modified method of average error is used to determine the amount of error from objective equality. One-half of the determinations were taken with the variable line on S's left and the other half with this line on S's right. A random order of one half of the initial settings of the variable line were larger and one half smaller than the fixed line. Each time the slider is moved S is to report whether the variable line is larger, equal to, or smaller than the fixed line. The Error score is the total error in centimeters. The Difference score is based on the difference in error when the initial setting of the variable line is larger and when it is smaller than the fixed line. The Difference score was included for analysis in addition to the Error score since Jenkin and West (1959) suggested the difference score as a sensitive discriminator between normal and organic groups.

Tests 33 and 34. Reaction Time: Simple and Choice

The Reaction Time Test (Benton and Blackburn, 1957) involves a finger reaction to the onset of a visual stimulus. The light stimulus is preceded by a buzz of 2 seconds duration which acts as a ready signal for S. Two lights are situated directly in front of S on an upright panel connected to two microswitches. In the Simple Reaction Time task only the light directly in line with the switch for the preferred hand is used. The S is instructed to press the switch only when the light comes on. Five practice trials are followed by fifteen test trials. The score is the mean latency for the fifteen trials. In the Choice Reaction Time situation S is told that after the buzzer sounds one of the two lights will come on, and he is to press the switch directly below the light that appears. Five practice trials are followed by sixteen random presentations of the right and left lights. Once again the score is the mean of the latencies recorded for all the trials.

Variable 35 was the age in years of the subject.

METHOD

The sample of Ss selected for testing consisted of 100 persons between the ages of 16 and 70 years of age. Fifty of these Ss were between 16 and 35 years and another fifty were between 36 and 70 years of age. An attempt was made to keep the distribution of Ss within these age groups constant across specific age ranges. In the 16-35 year group the range was five years while in the 36-70 group the range was increased because of the extensive period under consideration. Table 2 presents the distribution of Ss within the various age groups.

TABLE 2

Distribution of Subjects within the Different Age Groups

Age Group	16-20	21-25	26-30	31-35	36-45	46-55	56-65	66+
Number	16	11	13	10	15	14	12	9

The criteria used for selection of Ss were age, freedom from any known injury which might have resulted in brain damage, and availability. The Ss were questioned prior to testing concerning their hospitalization history in order to obviate the possibility of including a brain injured person in the sample. Availability became an obvious criterion after attempts to obtain a sample stratified for occupation and education were unsuccessful. An important

consideration became the willingness to submit voluntarily to a test battery which involved six hours of testing spread over a number of test sessions.

The effects of the departure from what would be considered an adequate sample are difficult to evaluate. The reason for attempting to incorporate a sample stratified for occupation and education was that it seemed reasonable to assume that these variables would increase the range of scores observed. The principle of maximizing variability in an exploratory factor analytic study has been formulated by Thurstone (1947, p. 324 ff.). The assumption being made is that the significant sources of variability are known prior to the initiation of testing. Such was not the case for the brain damage battery as applied to normal individuals, except for certain of the tests which are known to vary with age (Reitan, 1956; Stein, 1962). Variability associated with age was maximized in this study. In the absence of any specific hypotheses concerning other parameters of importance in increasing variability Thurstone has stated that "we proceed by inviting any conveniently available group of subjects in the hope that they will differ markedly among themselves in the several parameters or factors of the domain to be investigated." (Thurstone, 1947, p. 325). In these terms the sample selected would be considered adequate for this exploratory study.

The placement of the tests in the battery was directed by

several considerations. The primary ones were concerned with attempting to intersperse the tasks so as to maintain the interest and motivation of the S. The shorter tasks were alternated with longer ones, and tests which seemed to require certain abilities were placed so that tests of other abilities would intervene. This consideration was felt to be of greater importance for those tests requiring continued perceptual or motor components because of the possibility of satiation effects. The simpler tests, which were felt not to require a high degree of ability, were placed at the start of the battery in an attempt to alleviate apprehension concerning the test situation.

Testing was conducted with individual Ss in multiple test sessions. The length of the test session varied depending on the age of the S and the amount of time he had allotted for the session. If an entire morning were involved then a break for coffee was introduced. Testing was discontinued if S began to feel tired.

The testing took place in two different rooms at the university of Alberta Hospital. Due to renovations at the hospital it was necessary to move the battery to a different room after approximately sixty Ss had been tested. A similar number of Ss in the various age groups had been tested before the move. It would be expected, therefore, that the change in test location affected the groups similarly.

The analysis of the data included determination of variable

intercorrelations and factor analyses for three separate age groups; one for the entire age range, 16-70, the others for the separated age groups, 16-35, 36-70. The factor analysis of the data for the entire age range was intended for purposes of interpretation of the factors extracted, and for deriving a factor score matrix which could be used to determine changes in factor scores as a function of age. The separate factor analyses were intended primarily for comparison purposes. The orthogonally rotated solutions for the 16-35 and 36-70 age groups were submitted to invariance analysis to determine the degree of relationship existing between the factors extracted in the two groups.

All of the analyses incorporated in this study were performed on the IBM 7040 at the University of Alberta Computing Center. The programs for these analyses were made available by Dr. S. Hunka. Three separate factor analyses were performed on the data for comparative purposes. The first involved a principal axes solution (Harman, 1960) with 1's being used for the diagonal elements. The second analysis employed the same solution after the raw data had been normalized. The last solution attempted was the Alpha analysis recently reported by Kaiser and Caffrey (1965). The Alpha solution is similar to canonical factor analysis (Rao, 1955), except that the analysis is performed on a correlation matrix of the common parts of the intercorrelated variables. The initial estimate of the communality entry is the squared multiple correlation of each

variable on the others in the matrix. The solution is then iterated until the communalities converge. A desirable feature of this solution is that the same factors are extracted despite a rescaling of the measurement units of the observed variables (Kaiser and Caffrey, 1965, p. 7). A comparison of the factor plots after Promax rotation (Hendrickson and White, 1964) indicated that although the three solutions were similar, the Alpha analysis yielded what appeared to be a better simple structure. The Alpha solution was, therefore, used for all the analyses with a .01 criterion of communality convergence.

The criterion used for determining the number of factors to retain for rotation was that outlined by Kaiser and Caffrey, (1965). They have suggested that only those factors with "positive generalizability" should be retained. The analytic criterion corresponding to this psychometrically desirable one is the acceptance of all factors which have associated eigenvalues greater than one. For all matrices the Varimax analytic criterion (Kaiser, 1958) was used for preliminary rotation. Factor matrices that were to be used for interpretation purposes were further rotated to oblique simple structure using the Promax method suggested by Hendrickson and White (1964). The Promax method begins with an orthogonally rotated factor matrix, such as a Varimax matrix, and powers the elements of the matrix so as to maximize the differences between the high and low loading elements. The method then involves the determination of a least squares fit of the powered matrix to the orthogonal matrix

of factor loadings. The Procrustes equation outlined by Hurley and Cattell (1962) is used for this purpose. Standard formulae, outlined by Harman (1960), can then be used to determine the matrix of factor correlations, and the pattern on the primary matrix. In the present analyses, the structure on the reference matrix was used for interpretation. One problem in using the Promax method involved the selection of a value for k, the power to which the elements of each Varimax matrix were taken. After several values of k, ranging from two to six were attempted, the power 2 and power 4 solutions were selected and plotted in two dimensional sections. Inspection of these sections for the two different solutions indicated a better simple structure for the power 2 rotations and these were retained for the analyses.

The invariance analysis selected for relating factors between the 16-35 and 36-70 age groups was that outlined by Kaiser (1960). The selection of this particular analysis was based on an empirical and theoretical study of invariance conducted by Crawford (1964). Kaiser's invariance analysis can be applied to the case where the same variables are administered to two different groups of individuals. The method involves the placement or rotation of the common tests from the two studies in the same space with the same origin. The measure of invariance is taken to be the cosine of the angles between the factor vectors after the test vectors have been rotated for maximum overlap. In the present study the orthogonally

rotated Varimax solutions were submitted to the invariance analysis.

The final analysis undertaken was the determination of an n x r factor score matrix based on the factor solution for the entire age range, 16-70. The method used for this purpose was based on Kaiser's (Kaiser, 1962) modification for the determination of factor score estimates. The factor matrix used for this analysis was the Promax rotated matrix with a k value of two. This particular matrix was selected for two related reasons. It was felt to be desirable to select that factor matrix for the 16-70 age group upon which the interpretation of the factors had been based. This selection would allow a more meaningful discussion of possible changes in factor scores as a function of age. The related reason is based on the degree of obliquity observed between the factors after the Promax rotation. Use of the Promax rotation would have been obviated with a high degree of obliquity because factor changes observed for one factor would not necessarily have been independent of a correlated factor. In view of only a slight degree of relationship, as indicated by the cosine matrix, however, the increase in meaningfulness of discussion was felt to more than compensate for the possible lack of independence. Finally, the factor scores obtained for each factor across age groups was submitted to an analysis of variance to determine whether any of the changes were significant.

RESULTS AND INTERPRETATION OF FACTORS

The basic analyses for the 16-70 age group data are outlined in Tables 3, 4, and 5. Convergence for the Alpha analysis of this age group was attained after thirteen iterations and twelve factors were retained for rotation. The analyses preliminary to the Promax factor matrix are given in Appendix B. The Promax oblique factor matrix reported was that of the structure on the reference projections. This matrix was selected for interpretation because the criteria of simple structure, as outlined by Thurstone (1947, p. 335), were more closely approximate.

For purposes of interpreation of the factors the convention to include for consideration variables having loadings greater than .30 was accepted. Maximum weight for the interpretation was, however, assigned to variables having substantially higher loadings than this minimum. This approach is consonant with the intended purpose of the simple structure concept, which is to provide a psychometrically meaningful basis for the test vector space.

FACTOR I

The variable with loadings above .30 on Factor I are:

18.	Tactual Performance - Localization	+.657
17.	Tactual Performance - Memory	+.602
14.	Memory-for-Designs	+.597
20.	Hooper Visual Organization	+.549
16.	Tactual Performance - Latency	-.545
1.	Coloured Progressive Matrices	+.498
13.	Porteus Maze	+.449
22.	Halstead Category	+.443

TABLE 3

Promax Factors

Structure on the Reference Matrix

16-70 Age Group

	I	II	III	IV	V	VI
1	.498	.103	-.138	-.088	.021	-.022
2	.254	-.043	-.078	-.192	.144	.112
3	.016	.305	.522	.001	-.003	.056
4	.043	-.009	.493	.068	.122	-.027
5	-.138	.169	-.001	.211	.016	.312
6	.210	.076	.372	.232	.031	.020
7	.068	-.115	.149	.026	-.035	-.008
8	.180	-.081	.028	.044	.045	-.061
9	.012	.276	.151	-.047	.194	-.037
10	.266	.395	.136	-.062	-.080	-.052
11	-.047	-.058	.473	-.137	-.164	.052
12	-.073	.020	.034	.018	.082	.024
13	.449	.213	-.306	-.086	-.094	.004
14	.597	.228	.082	-.014	-.003	-.094
15	-.018	.115	.131	-.337	.138	-.033
16	-.545	-.127	-.132	.077	.049	.036
17	.602	-.007	.241	-.020	-.003	-.021
18	.657	-.078	.313	-.124	.041	.092
19	-.252	-.446	-.026	.283	-.114	.098
20	.549	-.038	.028	.097	-.049	.115
21	.010	-.028	-.008	.003	.839	.023
22	.443	.212	.054	.092	.113	.102
23	-.141	.032	-.130	-.062	-.023	.036
24	.296	.434	-.046	-.040	.121	.109
25	-.113	.020	.100	-.051	.096	-.021
26	.044	-.074	-.277	.192	-.115	.037
27	-.012	.667	-.005	-.205	.001	.164
28	.138	.618	.166	-.024	-.077	-.020
29	-.063	.075	.028	.091	-.095	-.035
30	.102	-.123	.154	-.253	-.097	.212
31	.035	-.315	-.055	-.131	.061	-.518
32	-.130	.035	-.053	.139	-.072	-.632
33	-.143	-.152	.144	.730	-.009	-.032
34	.052	-.276	.193	.500	.098	.008
35	-.233	-.318	-.592	.054	.062	-.060

TABLE 3 (Cont'd)

	VII	VIII	IX	X	XI	XII
1	.158	.136	-.067	-.006	.234	-.011
2	.300	.318	.063	-.111	.068	-.011
3	-.082	.114	.059	-.017	.190	.250
4	.119	.117	-.103	.005	.001	.034
5	.056	.014	-.100	-.126	-.064	.297
6	-.070	-.028	-.047	.106	-.068	.028
7	-.047	.014	-.113	.028	.512	.089
8	.479	.001	.058	.036	-.131	.003
9	.446	-.011	-.154	-.007	.067	-.020
10	.160	.088	.198	.077	-.142	-.225
11	.354	-.127	.107	-.032	.063	.148
12	-.010	-.075	.071	.670	.016	-.020
13	.005	-.021	-.108	.059	.111	.179
14	-.008	-.052	-.085	.097	-.001	.117
15	-.011	.270	-.027	.112	.209	-.004
16	.051	.055	-.047	-.052	.203	-.251
17	-.007	.039	.084	-.173	-.036	-.070
18	-.015	-.097	.017	-.056	.104	-.052
19	-.044	.006	-.048	-.066	.154	-.218
20	.196	-.018	-.133	-.035	.020	.116
21	.099	-.076	.042	.042	-.012	.011
22	.150	.032	-.082	.056	.082	-.058
23	-.017	.067	-.157	-.004	-.097	-.537
24	-.032	.056	.249	-.084	.044	.125
25	.001	.081	.636	.002	-.216	.143
26	.002	.094	.471	.108	.095	.009
27	-.108	-.072	-.012	-.018	-.125	-.043
28	.054	.171	-.190	-.044	.050	.015
29	-.018	.674	.127	-.052	-.018	-.046
30	.012	.340	-.048	.387	-.390	.194
31	-.073	.083	-.038	-.108	.058	.085
32	.086	-.037	.006	-.025	-.022	-.037
33	.014	.029	.022	.037	.136	.124
34	-.092	.121	.006	-.008	-.104	-.090
35	-.086	.048	-.068	-.142	-.173	.026

TABLE 4

16-70 Age Group Promax Transformation Matrix

.635	-.034	-.019	.032	-.026	-.007	-.023	-.020	-.005	-.016	.001	.002
-.064	.513	-.002	.016	-.014	-.021	-.007	.002	.010	-.047	.003	-.006
-.022	.003	.444	.045	.006	-.023	-.004	.026	-.033	-.021	.002	-.012
.065	.013	-.006	.516	.044	-.013	-.004	.003	.016	-.008	.002	.010
-.037	-.025	-.031	.038	.685	.013	-.012	-.027	.020	.036	.011	.011
-.033	-.006	-.008	-.026	.019	.507	-.002	-.013	-.008	.013	-.013	-.002
-.090	-.020	-.016	-.005	-.028	-.022	.395	.001	.021	.016	-.034	.001
-.074	.018	.000	.031	-.052	-.028	.001	.464	.016	.014	-.018	-.007
.020	-.008	.014	.027	.026	.004	-.003	-.009	.415	-.017	.000	.024
-.056	-.046	-.027	.019	.076	-.002	-.010	-.002	.003	.524	-.000	-.010
-.013	-.051	.068	.024	-.011	-.007	-.026	-.020	-.018	.030	.313	.004
-.027	-.019	-.044	.038	.038	-.036	.018	-.010	.057	-.016	-.014	.338

TABLE 5

16-70 Age Group — Primary Factor Correlations

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.000	.416	.123	-.298	.174	.151	.479	.368	.015	.321	.088	.221
2	.416	1.000	.030	-.186	.094	.166	.341	.098	.061	.324	.229	.191
3	.123	.030	1.000	-.203	.088	.054	.027	.028	-.112	.158	-.368	.277
4	-.298	-.186	-.203	1.000	-.247	.060	-.172	-.358	.030	-.226	-.039	-.294
5	.174	.094	.088	-.247	1.000	-.050	.197	.271	-.133	-.123	.073	.015
6	.151	.166	.054	.060	-.050	1.000	.211	.191	-.043	.089	.006	.214
7	.479	.341	.027	-.172	.197	.211	1.000	.258	-.000	.100	.344	.053
8	.368	.098	.028	-.358	.271	.191	.258	1.000	-.112	.183	.109	.262
9	.015	.061	-.112	.030	-.133	-.043	-.000	-.112	1.000	.007	.198	-.386
10	.321	.324	.158	-.226	-.123	.089	.100	.183	.007	1.000	-.148	.252
11	.088	.229	-.368	-.039	.073	.006	.344	.109	.198	-.148	1.000	-.204
12	.221	.191	.277	-.294	.015	.214	.053	.262	-.386	.252	-.204	1.000

This factor is interpreted as perceptual organization. The factor may be characterized by an ability to integrate or organize the relevant aspects of the perceptual field. The interpretation of this factor was made difficult by the apparent memory component in the high loading variables. This suggested, however, that perceptual organization or integration would facilitate proficiency on those tests involving a memory component. The emphasis on organization rather than the perceptual aspects was made evident by the near zero loadings of strictly perceptual tests such as Retinal Rivalry (3), Halstead's Rhythm Test (15), and Halstead's Speech Sounds Test (21). It might be interesting to include in a future analysis the Block Design and Object Assembly sub-tests of the WAIS which have consistently been used to identify a perceptual organization factor in analyses of the WAIS. The identification of the same factor with high loadings of these sub-tests would tend to corroborate the present interpretation.

FACTOR II

Eight variables have loadings above .30 on Factor II. These are:

27.	Purdue Pegboard - Total	+.667
28.	Purdue Pegboard - Assemblies	+.618
19.	Trail Making Latency	-.446
24.	Grayson Perceptualization	+.434
10.	Symbol Gestalt	+.395
35.	Age	-.318
31.	Muller-Lyer-Error	-.315
3.	Retinal Rivalry	+.305

This factor is interpreted as perceptual-motor speed. The high loading variables on this factor would seem to require an integrated perceptual-motor response under speeded conditions. The importance of the perceptual aspect of this factor is indicated by the high loadings of variables 19, 24, and 10, which appear to depend more heavily upon perceptual information than motor co-ordination, and the loading of tests 31 and 3, which do not require a motor response.

FACTOR III

This factor is interpreted as perceptual resolution. The relevant high loading variables are:

35.	Age	-.592
3.	Retinal Rivalry	+.522
4.	Modified Word Learning	+.493
11.	C.F.F. - Mean	+.473
6.	Organic Integrity	+.372
18.	Tactual Performance - Localization	+.313
13.	Porteus Mazes	-.306

The title of this factor is meant to be descriptive of a perceptual phenomenon analogous to the resolving capacity used to describe visual resolution (Westheimer, 1965). The purely sensory use of the term resolving capacity could be considered in terms of at least two dimensions; temporal and spatial. Temporal resolution for visual phenomenon would include such measures as the critical flicker frequency while a measure of spatial resolution for the same modality would be the Landoldt C. The interpretation of perceptual resolution was meant to indicate a perceptual

source of variance analogous to the temporal dimension of resolving capacity. This particular interpretation was suggested by the high loading tests, such as variables 3, 4, and 11, which are more perceptual than sensory in nature, and by variables 3 and 11 which seem to require a perceptual form of resolving power. This factor would appear to be most similar to Halstead's Power Factor (Halstead, 1947). The type of tests loading Halstead's Power Factor, and what has been termed a perceptual resolution factor are at least superficially similar.

The high negative loading of age on Factor III suggests that the factor is particularly susceptible to the aging process. This finding is consistent with studies reporting a monotonic decline as a function of age for one of the measures, critical flicker frequency.

The one test loading that initially appeared to be inconsistent with the interpretation was Modified Word Learning (4). The high loading of this variable could be explained, however, by the manner of presentation. The words and meanings are presented varbally to the _S_, and he is required to memorize these meanings. It is suggested that an important aspect of the test situation is _S_'s reception of the orally presented test material. Variability associated with reception could account for part of the variability in scores obtained for the _Ss_ tested.

FACTOR IV

The high loading variables for Factor IV are:

33.	Simple Reaction Time	+.730
34.	Choice Reaction Time	+.500
15.	Halstead Rhythm Test	-.337

This factor is considered to be uninterpretable in this battery for at least two reasons. In addition to being underdetermined, there is a possibility of experimental dependence between the two reaction time variables.

FACTOR V

Factor V is considered to be unique in this battery. Only one test has a projection above .30 and that is Halstead's Speech Sounds Test with a loading of .839. The inclusion of other comprehension tests such as have been studied by Schuell, Jenkins, and Carroll (1962) might provide a basis for identification of this factor.

FACTOR VI

Three variables have loadings above .30 on this factor. These are:

32.	Muller-Lyer - Difference	-.632
31.	Muller-Lyer - Error	-.518
5.	Apparent Motion	+.312

This factor is considered to be uninterpretable because of underdetermination and possible experimental dependence. One could speculate that the high loading variables suggest a bipolar

illusion factor. This speculation, however, would be based on the apparent content of the high loading variables which could be misleading without other sources of possible identification.

FACTORS VII - XII

The remaining factors extracted in the 16-70 age group analysis are considered uninterpretable. They consist of triplet factors, with the possibility of experimental dependence, and doublet or unique factors. The high loading variables for these factors are indicated in Table 6.

TABLE 6

High Loading Variables for Factors VII - XII

Factor	Variables	Projection
VII	Grassi-Accuracy	+.479
	Grassi-Time Credits	+.446
	C.F.F. Mean	+.354
VIII	Kahn Test - Symbolization	+.674
	Kahn Test - Recall	+.340
	Proverbs	+.318
IX	Sound Localization - Separation	+.636
	Sound Localization - Localization	+.471
X	C.F.F. Deviation	+.670
	Kahn Test - Recall	+.387
XI	Binaural Beats	+.512
	Kahn Test - Recall	-.390
XII	Minnesota Percepto-Diagnostic	-.537

The second major analysis of this study involved the invariance analysis applied to the Varimax solutions of the separately factored data for the 16-35 and 36-70 age groups. The relevant matrices leading to the Varimax factor solutions for the two groups are outlined in Appendices D and E. Thirteen factors were extracted in the 16-35 age group and twelve in the 36-70 group. Communality convergence was established after eight iterations in the former group and after six in the latter. In performing the invariance analysis the communality vectors of the 36-70 group analysis were rotated to the position of the 16-35 group analysis rather than the reverse since the former involved fewer factors.

The Varimax factor matrices for the two groups and the cosine matrix indicating the degree of relationship between the two are given in Tables 7, 8, and 9. The important points to be noted in the comparison matrix become evident when it is contrasted with an identity matrix. The identity matrix (i.e., a square symmetric matrix with unities as diagonal elements and zero for off-diagonal elements) would be expected when the factors are identical and the order of extraction of factors for the two studies had been the same. The difference between Table 8 and an identity matrix are obvious. The first point to be noted is that the matrix is not square symmetric. This finding was expected since the number of factors extracted was not the same for the two factor solutions compared. Secondly, the highest entries in the matrix are not the

TABLE 7

16-35 Age Group Varimax Factors

	I	II	III	IV	V	VI	VII
1	.137	.142	.175	.270	.613	.008	.099
2	.181	.008	.162	.695	.203	.074	.238
3	-.197	.089	.040	-.032	-.038	-.130	.116
4	.100	-.059	.121	.009	-.001	-.130	.012
5	-.187	.235	.029	.178	.289	-.027	.395
6	.129	.003	-.138	-.017	.005	.068	-.126
7	-.066	-.057	-.001	-.004	.083	-.070	.053
8	.041	.009	.128	.210	.300	.109	-.064
9	.083	-.096	.823	.077	.125	-.047	.052
10	.198	.096	.281	-.138	-.219	.557	-.113
11	.054	-.062	.062	.122	-.063	-.082	.061
12	-.067	.040	.054	-.800	.059	.086	-.058
13	.326	.250	.286	.189	.235	-.031	.105
14	.227	.057	.447	.064	.252	.053	-.017
15	-.020	.025	.072	-.106	.039	-.051	-.057
16	-.607	-.075	.038	.210	-.011	.058	-.296
17	.788	.020	.173	.190	.113	.037	-.071
18	.756	.141	.066	.136	-.054	-.093	-.276
19	-.374	-.386	-.385	.127	.032	-.060	-.180
20	.246	.392	.303	.030	.164	.012	.071
21	-.047	.072	.178	.100	.008	.023	.028
22	.153	.401	.449	.314	-.033	.021	-.037
23	-.125	-.041	-.099	.142	-.035	.517	-.118
24	-.005	.140	.071	.170	-.168	.017	.611
25	.020	.048	-.036	.116	-.802	-.021	.088
26	.024	.193	-.210	-.209	-.019	.468	.165
27	.001	.184	.375	-.056	.085	.096	.360
28	.165	.017	.338	.249	.160	.149	.240
29	-.239	.183	.192	.348	-.178	.141	-.138
30	.190	.277	.035	-.181	-.140	-.083	.099
31	-.070	-.691	-.057	.055	-.064	-.099	-.075
32	-.033	-.836	.090	-.053	.044	.049	-.098
33	-.369	-.051	.030	-.035	.277	.196	-.186
34	-.183	-.034	-.010	.113	.197	.735	.028
35	-.157	-.089	-.012	-.000	.168	-.212	.618
Sums of Squares	2.494	2.067	2.035	1.934	1.742	1.593	1.575

TABLE 7 (Cont'd)

	VIII	IX	X	XI	XII	XIII
1	.069	-.100	-.083	.033	.118	-.048
2	.172	.077	.064	-.094	.054	-.044
3	.257	.408	-.047	.015	-.017	.037
4	.831	.200	.159	-.044	.146	.015
5	.116	.066	-.157	-.033	-.038	.054
6	.078	.757	.006	-.026	.085	.121
7	-.005	-.045	.096	.855	.175	.185
8	.227	-.064	.197	-.292	.401	.257
9	.164	-.202	.041	.097	.097	.138
10	-.015	.050	.094	-.019	.008	.066
11	.014	.234	.018	.168	-.051	.739
12	.152	.136	.147	-.062	-.049	-.163
13	-.197	-.173	-.034	-.116	-.209	-.207
14	-.037	.396	.047	-.329	.120	.176
15	.084	.059	.613	.106	.025	.031
16	-.204	.030	-.021	.258	.063	-.212
17	.033	.044	.031	.045	-.028	.031
18	-.004	.097	-.066	-.032	.051	-.055
19	-.131	-.101	-.075	.061	-.152	.076
20	.059	-.035	-.265	-.284	.031	.008
21	.106	.099	.086	.164	.619	-.059
22	-.018	.070	-.099	-.222	.261	-.157
23	-.024	-.292	.522	-.072	.086	-.062
24	.024	-.037	-.077	.114	.006	.020
25	.108	-.042	-.052	-.027	-.022	.055
26	-.086	-.172	-.271	.054	-.140	-.103
27	-.051	.045	.129	-.052	-.002	-.233
28	.209	.065	.324	.066	-.123	-.350
29	.256	.066	.140	-.072	-.491	-.032
30	.285	.402	.363	-.067	-.318	.107
31	.032	.010	-.045	-.031	-.030	-.132
32	-.005	-.102	-.031	.046	.073	.240
33	.002	.174	-.428	.090	-.146	.118
34	-.037	.070	-.093	-.079	.039	-.089
35	-.545	-.121	.086	-.112	.223	.080
Sums of Squares	1.547	1.501	1.451	1.304	1.259	1.187

TABLE 8

36-70 Age Group Varimax Factors

	I	II	III	IV	V	VI
1	-.020	.512	.565	-.306	.041	.098
2	-.160	.340	.180	-.387	.137	.155
3	.657	.089	-.039	.048	-.114	-.008
4	-.033	.143	-.046	.171	-.134	-.051
5	.287	-.255	-.139	.354	-.132	-.043
6	.078	.083	.059	.520	.020	-.036
7	-.101	-.209	.251	.118	-.257	.245
8	.050	.150	-.010	-.073	.238	.725
9	.130	-.048	-.015	-.019	-.033	.129
10	.530	.474	-.006	-.221	.040	.183
11	.130	-.167	-.108	-.120	.211	.223
12	-.005	.088	.082	.059	.624	.051
13	.114	.023	.824	-.080	.020	-.010
14	.253	.351	.585	.032	-.055	.228
15	.249	.086	.082	-.337	-.136	-.065
16	-.209	-.276	-.282	-.173	.143	-.128
17	.051	.714	.077	.075	-.071	.158
18	.171	.449	.172	.049	-.183	.452
19	-.546	.028	-.276	.231	.041	-.127
20	-.087	.231	.264	.106	-.323	.515
21	-.090	.131	.001	-.051	-.020	.015
22	.015	.359	.419	.117	-.071	.076
23	-.263	.068	-.088	-.083	-.059	-.222
24	.485	.546	.273	-.018	.160	.040
25	.050	.021	-.272	.027	.653	-.004
26	-.125	.132	.068	-.033	.456	.018
27	.612	.084	.085	-.148	.051	-.356
28	.823	-.034	.273	.055	-.141	.095
29	-.076	.203	-.046	-.040	.071	-.060
30	-.006	.089	.081	-.139	.107	.095
31	-.386	-.002	.101	-.331	-.325	.183
32	.056	-.015	.028	.059	.134	-.038
33	-.105	-.110	-.047	.701	.161	.038
34	-.387	.108	-.137	.562	-.080	.175
35	-.639	-.124	.051	-.124	-.171	-.153
Sums of Squares	3.504	2.342	2.210	1.987	1.707	1.606

TABLE 8 (Cont'd)

	VII	VIII	IX	X	XI	XII
1	.146	-.015	.192	.047	-.016	.066
2	.234	-.038	.236	.196	-.029	.294
3	-.188	-.030	.255	-.014	.321	.114
4	.110	.011	-.000	.068	.644	.005
5	.102	.061	-.046	-.087	.016	.096
6	.110	.064	.143	.026	.051	-.163
7	-.104	-.245	.399	-.296	-.048	.244
8	.097	.121	-.044	.058	.062	-.000
9	.763	-.016	-.060	.272	.114	.046
10	.112	.117	-.019	-.027	-.109	-.146
11	-.056	.068	-.202	-.102	.534	.182
12	.107	.029	-.128	-.056	-.074	-.040
13	.095	.138	.042	-.006	-.048	-.032
14	-.205	.194	-.162	.081	-.119	.017
15	.145	.083	.465	.294	.088	.158
16	.135	-.606	.045	-.111	.035	.038
17	-.033	.162	.163	.082	.186	-.017
18	.034	.125	.059	.140	.090	.291
19	.039	-.313	-.014	-.418	.112	.213
20	.088	.105	.003	-.103	-.028	.042
21	.157	-.074	-.000	.778	-.001	.078
22	.553	.104	-.006	-.072	.002	-.125
23	-.003	-.353	-.352	-.036	-.254	-.007
24	.110	.065	.067	.212	-.262	.129
25	-.290	.163	.129	.265	.079	-.116
26	-.086	-.128	.288	-.149	.038	-.110
27	-.126	.026	-.280	.084	-.198	.038
28	.274	.094	.075	-.101	-.043	-.149
29	-.085	-.047	.626	-.016	-.163	-.092
30	.090	.754	-.048	-.122	.052	.191
31	-.309	.023	.154	.250	.122	-.231
32	.003	-.115	.037	-.045	-.071	-.684
33	-.047	-.223	.098	-.124	.264	.056
34	-.114	.042	.161	.039	-.155	.085
35	-.167	-.089	.199	.111	-.406	.062
Sums of Squares	1.556	1.528	1.471	1.425	1.414	1.084

TABLE 9

Factor Similarity Matrix

36-70 Age Group

16-35 Age Group	1	2	3	4	5	6	7	8	9	10	11	12
1	.150	.562	.423	-.325	-.062	.304	-.402	.218	-.155	-.022	.193	-.077
2	.204	.203	.152	.075	.335	-.111	.264	.163	-.175	-.186	-.120	.754
3	.475	-.092	.326	-.081	.048	.243	.548	-.042	.066	.171	-.071	-.351
4	-.295	.440	-.076	-.040	-.312	.090	.185	-.061	.642	.196	-.026	.226
5	-.156	-.115	.444	.250	-.509	.205	.286	-.092	-.060	-.332	-.073	.108
6	.180	.451	-.270	.317	.264	.250	-.004	-.298	.043	-.161	-.471	-.215
7	.186	-.251	.291	.020	.111	-.061	-.255	.269	.409	.420	-.420	.128
8	.173	.139	-.152	.099	.202	-.059	.338	.158	.206	.135	.626	-.035
9	.444	.041	-.186	.609	-.441	-.005	-.235	.246	-.069	.106	.125	.058
10	.323	.015	-.448	-.555	-.423	-.047	.184	.160	-.129	-.037	-.257	.099
11	.416	-.183	.038	-.159	-.042	.059	-.275	-.681	.254	-.130	.244	.285
12	-.133	.062	-.023	.045	-.066	.200	.079	-.338	-.471	.728	.009	.216
13	-.102	-.320	-.266	-.019	.150	.819	-.053	.248	.080	-.086	.078	.188

diagonal elements. This observation suggests that the order of extraction for similar, if not the same factors, was different for the two age groups. The conclusion to be drawn is that the factors accounted for different amounts of variance in the two solutions. One other point to be noted is that the entries in the matrix are not unities and zeros. Table 9 lists the distribution of entries between 0 and ± 1.0. Inspection of Table 10 indicates only eleven entries greater than .500. Of these only ten correspond to the high row and column entries in the matrix. When the

TABLE 10

Distribution of Entries in the Comparison Matrix

Entry	0-.100	.101-.200	.201-.300	.301-.400	.401-.500
Number	47	39	31	12	16
Entry	.501-.600	.601-.700	.701-.800	.801-.900	.901-1.00
Number	4	4	2	1	0

factor orders are not the same for the two matrices being compared it would be expected that the high row and column entries would indicate similar factors and the degree of similarity. A permutation matrix would result when identical factors were being compared.

The results indicated in Tables 9 and 10 bring up an important question concerning invariance analyses. The question involves the determination of the significance of the entries in the comparison

matrix. In the present analysis the interpretation of similarity would depend on the minimum entry that could be accepted as indicating similarity. Acceptance of entries larger than .700 would mean that only three factors in the two analyses were similar. A minimum level of .600 would mean that seven of the factors would be considered similar. Entries at this level, however, could only be interpreted as indicating a moderate degree of relationship. It would seem reasonable, moreover, that only entries larger than .800 would indicate a high degree of relationship, while entries smaller than .600 indicate only weak, if any relationship. In these terms only one of the factors observed in the 16-35 age group has a high degree of relationship with a factor in the 36-70 age group and six other factors show moderate degrees of relationship.

One other comparison between the two Varimax solutions is of interest. Table 11 lists the distribution of test variance for the two solutions. Since the order of factor extraction was different for the two groups the factors observed in the 36-70 age group have been paired with related factors in the 16-35 group. These have been indicated in parentheses following the factor observed in the 36-70 age group. Inspection of Table 11 reveals that only eleven of the thirty-four tests have related common factor variance in the two Varimax solutions. This finding essentially substantiates the results indicated by the invariance

TABLE 11

Distribution of Common Test Variance on Varimax Factors for the 16-35 and 36-70 Age Groups

Test	16-35 Age Group	36-70 Age Group
1	5	2(1),* 3
2	4	2(1), 4(9)
3	9	1, 11(8)
4+	8	11(8)
5	7	4(9)
6+	9	4(9)
7	11	9(4)
8	5, 11	6(13)
9+	3	7(3)
10	6	1, 2(1)
11	13	11(8)
12	4	5(5)
13	1	3
14+	3, 9, 11	2(1), 3
15	10	4(9), 9(4)
16	1	8(11)
17+	1	2(1)
18+	1	2(1), 6(13)
19	1, 2, 3	1, 8(11), 10(12)
20	2, 3	5(5), 6(13)
21+	12	10(12)
22+	2, 3, 4	2(1), 3, 7(3)
23	6, 10	8(11), 9(4)
24	7	1, 2(1)
25+	5	5(5)
26	6	5(5)
27	3, 7	1, 6(13)
28	3, 10, 13	1
29+	4, 12	9(4)
30	9, 10, 12	8(11)
31	2	1, 4(9), 5(5), 7(3)
32+	2	12(2)
33	1, 10	4(9)
34	6	1, 4(9)

*The number in parentheses indicates those factors in the 16-35 age group solution which have an entry greater than .5 in the comparison matrix to the factor being considered.

+Tests having similar factors accounting for at least part of the common factor variance in both age groups.

analysis which determined the degree of relationship of the factors when the tests have been matched. On the basis of these results it seems evident that for the majority of tests in the battery the common sources of variance are not the same for the two age groups.

The final analysis of the data obtained involved the determination of factor score estimates for each individual on each of the factors retained in the 16-70 age groups. The means of the factor scores for Ss in each of the age groups and the summary tables for the analyses of variance are listed in Appendix F. The plots of these factor scores for each factor as a function of age are given in Figures 1 to 4 and Appendix G. Although the plots for many of the factors are suggestive of possible changes with age the analyses of variance indicated significance for only two. The decline observed for Factor II was found to be significant ($F = 4.15$, $p < .01$; 7, 92 df) as was the decline indicated for Factor III ($F = 11.81$, $p < .01$; 7, 92 df). These factors have been termed the perceptual-motor speed and perceptual resolution factors respectively.

Further evidence of the significant decline with age for Factors II and III is given by the negative loading of age on these factors. As outlined in Table 3 the age variable has a projection of -.318 on Factor II and -.592 on Factor III. These results represent a more direct indication of the decline since the observed loadings represent the correlation between age and the true factor scores, whereas the obtained factor scores are only estimates of these true factor scores.

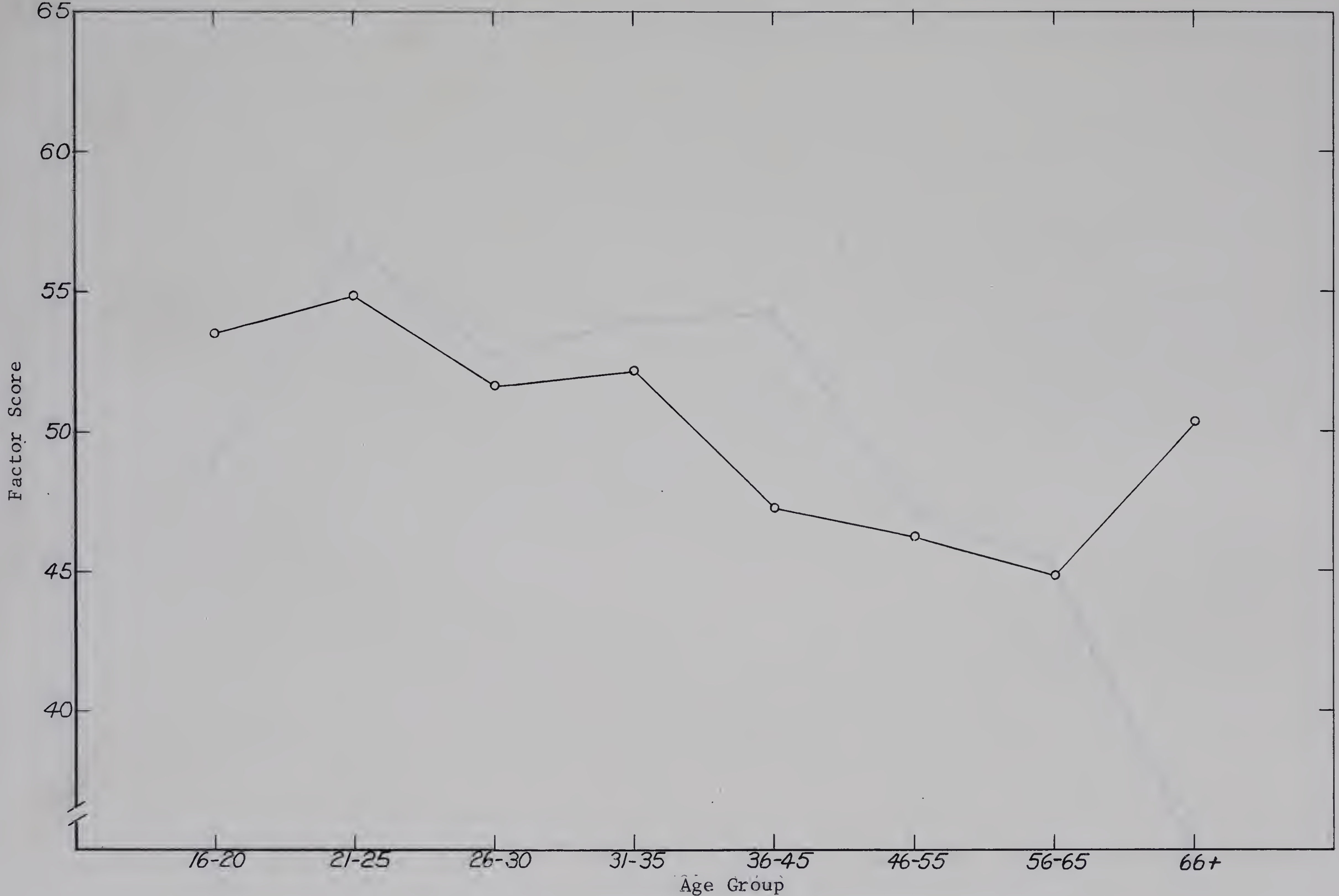

Figure 1. Factor I Scores as a Function of Age

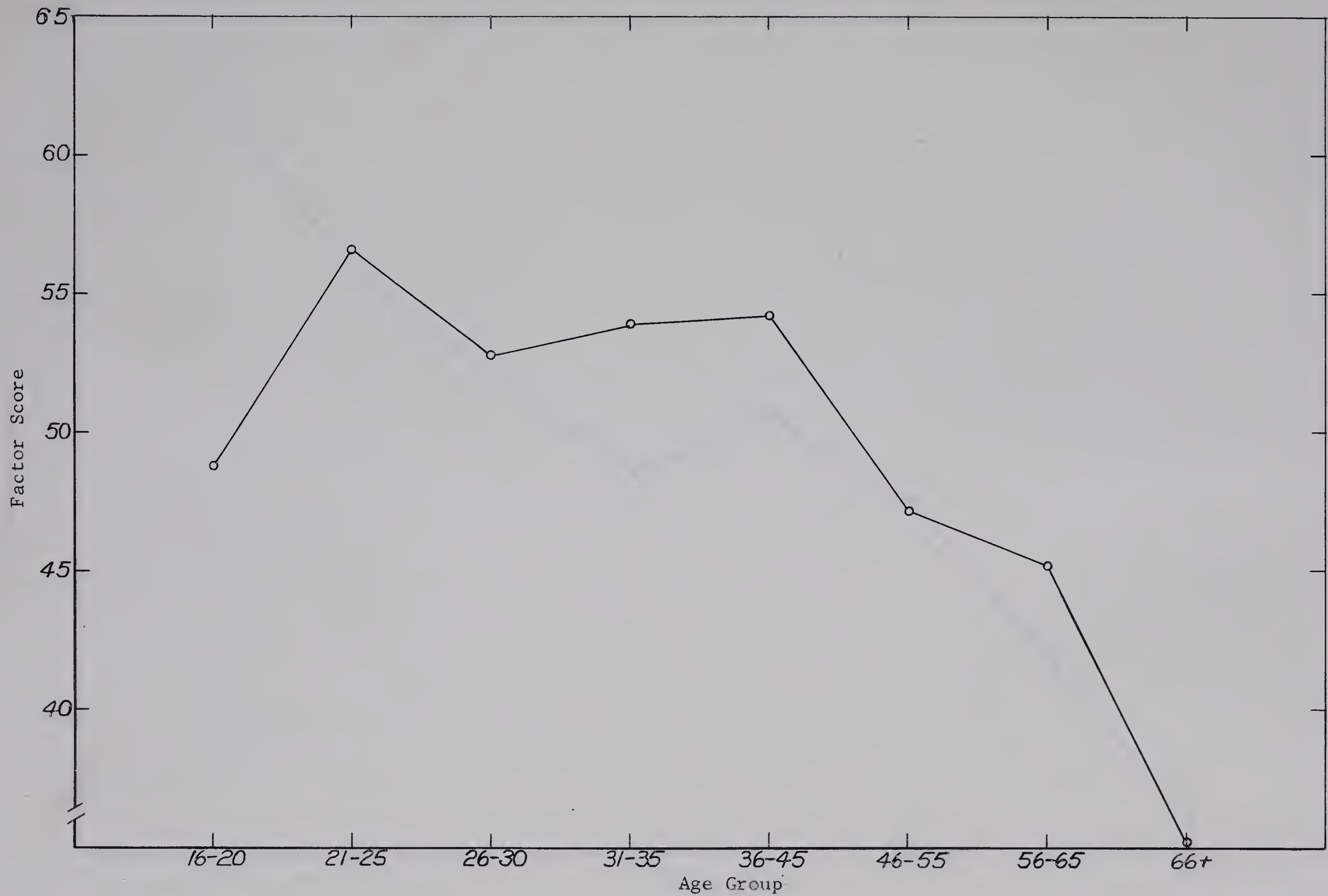

Figure 2. Factor II Scores as a Function of Age

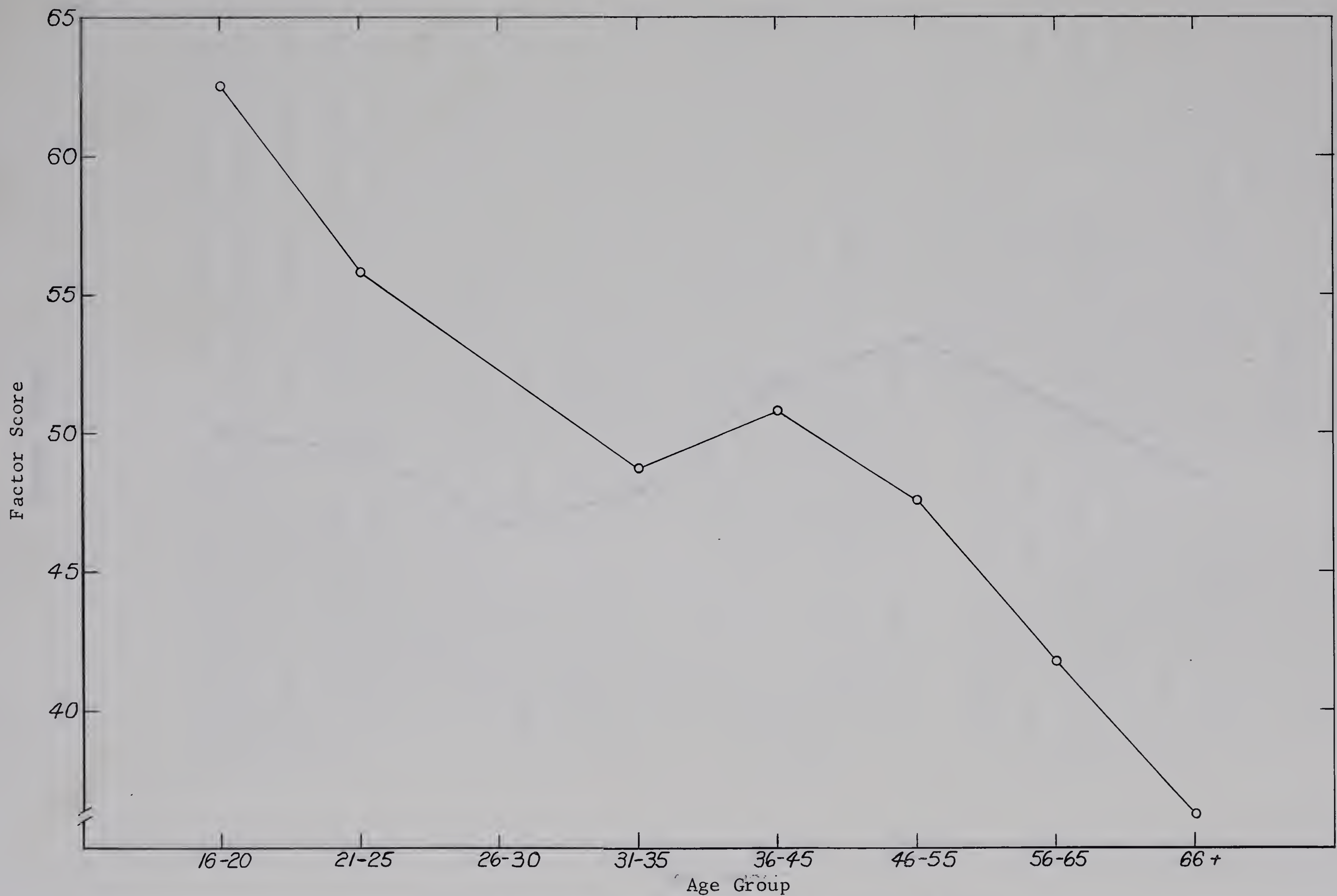

Figure 3. Factor III Scores as a Function of Age

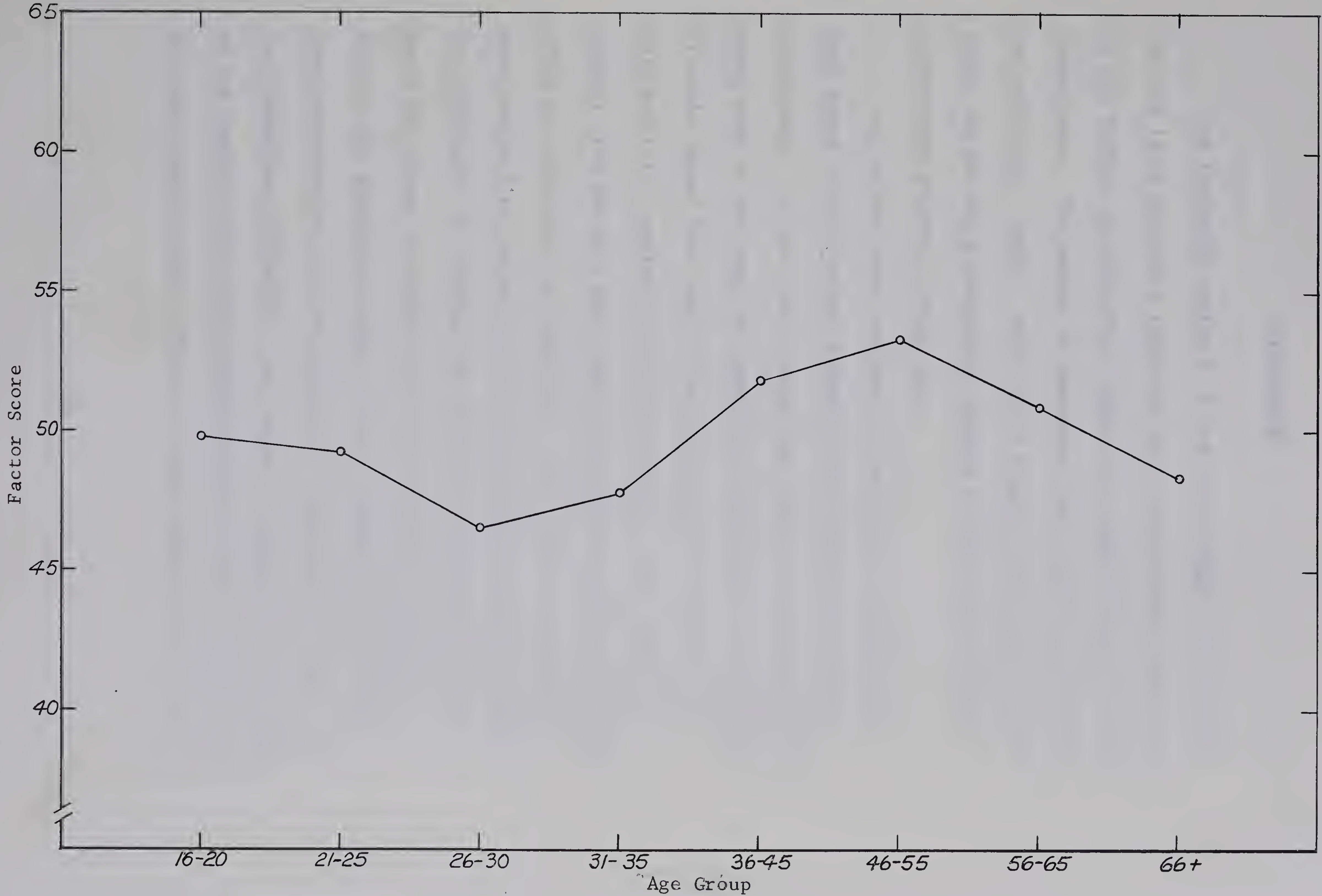

Figure 4. Factor IV Scores as a Function of Age

DISCUSSION

The factorial analysis of the brain damage test battery for the 16-70 age group indicates that the factorial composition of the battery is relatively complex when administered to normal individuals. The number of dimensions that could be identified was much less, however, which would suggest that several dimensions are not being adequately sampled by valid and reliable instruments presently being used.

All of the tests included in the present battery have been found to discriminate between brain damaged and normal individuals. If one could assume that these discriminations are being made on the basis of dimensions identified in this study, it would appear that many of the dimensions of interest are only partially sampled by this test battery. This would be evident from the fact that nine of the twelve factors extracted could not definitely be identified. The evidence provided by this analysis in conjunction with the assumption made, suggest the importance of studying the factorial composition of the tests for groups of normals and brain damaged individuals. A test of the assumption would involve a comparison of the factors extracted for the two differently constituted groups. If the comparison indicated a high degree of similarity, then some of the factors which were underdetermined in this battery should be investigated further. This would mean that the test battery

would be augmented with tests similar to the ones which indicated important sources of variance, but which could not be identified in the present battery.

Factor analytic studies of the WAIS administered to both normals and brain damaged groups have indicated substantial similarity in factor structures (Cohen, 1952; Berger, et al., 1964). In fact, in the Berger et al. study the authors concluded that differences observed over age were greater than that found for normal and brain damaged groups. In view of these suggestive findings further study of the possible dimensions of discrimination between normals and brain damaged groups would be warranted.

The results of this study also indicate a duplication in terms of the number of tests which discriminate on the basis of the same continua in normal samples. Nineteen of the tests included in the battery had substantial projections on one or other of the first three factors extracted. These factors were all interpreted as having a perceptual component, which could suggest the importance assigned to perceptual activities in the construction of brain damage tests. If one could assume that the sources of variance observed in this study are also the important dimensions of discrimination between normals and brain damage groups, then these results would suggest that differences in perception, and perceptual functioning integrated with response components, form an important aspect in the discrimination between these groups.

The relationship of the factors extracted in this study to those found in earlier factor analytic studies of brain damage tests would be difficult to assess. One possibly important difference was the use of a normal sample in this study as contrasted with brain damaged and other pathological groups in previous studies (Halstead, 1947; Jones and Wepman, 1961; Schuell, Jenkins, and Carroll, 1962; Coppinger, Bortner, and Saucer, 1963). A factor analytic study reported by Berger et al. (1964) has suggested a high degree of factor comparability between normals and brain damaged individuals for performance on the WAIS. Whether or not such a conclusion can be drawn for the tests used in this study awaits empirical investigation. A more critical difference obviating comparison between studies concerns the tests included for study. The Jones and Wepman (1961) and Schuell, Jenkins, and Carroll (1962) studies were concerned with tests of aphasia. In terms of the criteria outlined for the selection of tests in this study (Royce and Carran, 1964) the aphasia tests had not been included.

Although the tests included in the Coppinger et al (1963) study were essentially different, one of the factors extracted appears to bear at least a superficial resemblance to the Perceptual Resolution factor interpreted in this study. The factor reported in the Coppinger et al study was interpreted as "sensory alertness" and included loadings of C.F.F., Age, and a variable termed Shortest Noticeable Dark Time. The inclusion of different

content tests in the two studies precluded any further subjective comparisons between factors.

Perhaps the greatest degree of similarity between factors would have been expected in a comparison of Halstead's study (Halstead, 1947) and the present analysis. This expectation was based on the fact that many of Halstead's variables were included in the present battery. Inspection of the high loading variables in the facotr matrices suggested a similarity only between Halstead's P Factor and the Perceptual Resolution Factor observed in this study. A more direct comparison could not be applied since the number of variables used in the two studies were different and the number of factors extracted in this study was much greater than was found in Halstead's study.

The invariance analysis applied to the separately factored data from the 16-35 and 36-70 age groups indicates that the relationship between many of the factors determined for the two groups was not such as to indicate identity or similarity. Conclusions based on the invariance analysis must remain tentative in view of the small samples employed in the separate analyses contained in this study. The results could be treated as being suggestive, however, and the implications for psychometrics explored.

The one conclusion that seems directly indicated by this study, and the factor comparison studies that have been conducted on the WAIS, is that common test variance is not the same across

differently constituted groups of individuals. The principle associated with this conclusion was enunciated by Thurstone (1947) when he considered the appropriateness of different sample groups in the study of factorial invariance. Thurstone used an example based on the now famous box problem. He stated that "one could imagine a collection of boxes selected so that they were all of the same height. The variance in the height factor would then be zero. The factor loadings a_{jx} would vanish, and in fact, the rank would be 2 instead of 3, which is expected for most box populations. Hence <u>the factor loadings cannot be expected to be invariant from one population to a different population</u>". (Thurstone, 1947, p. 360).

The implications of Thurstone's principle are important not only for the problem of factorial invariance but also for psychometric theory. In the problem of factorial invariance the emphasis would be upon selection of sub-populations which are equally representative of the total population. Crawford (1964) has attempted to define invariant factors in terms of a number of simple structure matrices which approximate a unique simple structure matrix. The unique simple structure matrix would be the matrix of invariant factors. Crawford suggests that the average of the transformation matrices which transforms the factor matrices to maximum similarity should approach an identity matrix as the number of factor matrices considered approaches infinity. This statement can be summarized as

$$\mathcal{U} = \lim_{N \to \infty} \frac{1}{N} \sum_{i=1}^{N} T_i \longrightarrow I$$

where $\mathcal{U}$ is the unique simple structure matrix, T refers to the transformation matrix required to rotate one factor matrix to the best average of all the factor matrices, N is the number of independent factor matrices, and I is the identity matrix. The emphasis in this definition of an invariant factor is upon the elimination of minor differences existing between successive factorizations. Although Crawford did not address his discussion to the selection problem directly, it could be assumed that his definition applies to circumscribed sub-populations.

Meredith (1964a; 1964b) has recently discussed definitions of invariance and the conditions under which invariance would be expected. He has shown that an invariant factor pattern matrix exists which describes the regression of observed scores on factor scores when the sub-populations considered have been derived from a parent population under conditions of selection. Meredith has indicated that natural forms of selection, such as members of some social group or of the same occupation, are all that is necessary for factorial invariance to hold. The only restriction that Meredith imposes is that the rank of the sub-population matrices be the same as that of the parent. When an insufficient number of factors have been extracted in one of the sub-population matrices invariance would not be observed. In terms of Meredith's development, invariance could be indicated even when differences in test variance result in differences in the factor pattern matrices.

The discussion of factorial invariance has been concentrated on the determination of invariance over populations. The concept of factorial invariance as enunciated by Thurstone (1947) has other implications which are of importance to psychometrics. The development of these implications must be approached from another point of view. Relating back to Thurstone's discussion of the box problem assume that the absence of the "height" dimension in one of the sub-populations was not perceived prior to the factor analyses of the box populations. A reduction in rank for one of the matrices would have indicated the absence of a source of variability in that population. A comparison of the two factor matrices would have pointed to the absence of the "height" factor in one of the box populations. The lack of a height factor would not mean that the boxes in that population have no height. It simply means that this factor is a constant for that particular population. In this case invariance for the two matrices might not be observed because variability was not evident on one of the dimensions.

The importance of this principle for psychometrics, and especially for psychometric evaluation of ontogenetic changes, can be illustrated in terms of the basic factor analytic equation. For a specified population in which invariant factors had been determined, individual scores for a single test could be described in terms of a linear combination of relevant factor coefficients and the individual's score on that factor. For

two individuals from the same population the equations would be

$$Z_{11} = A_{11} F_{11} + A_{12} F_{21} + A_{13} F_{31} + A_1 U_{11}$$

and

$$Z_{12} = A_{11} F_{12} + A_{12} F_{22} + A_{13} F_{32} + A_1 U_{12}$$

In these equations the Zs refer to reproduced test scores, the As refer to factor loadings of the tests, U refers to the individual's score on the unique factor and F, his score in terms of each of the common factors observed for the test. The difference between the two individual scores would be given by differences in F and U values in the equation. Differences in F values would presumably reflect differences in abilities important for performance on that particular test. It is evident that for this defined population the test is compensatory. That is, the same scores could be obtained on the test through different combinations of F values for different individuals.

It is possible that for another population the equation for the test would have a different composition. This change in composition could take the form of an addition or subtraction of a factor or a modification of the importance of certain factors. The psychometric importance of changes in the equation for different groups would depend on whether or not the change involved a relevant source of variability. By a relevant source of variability is meant one which is important to the validity of the test. For purposes of discussion assume the following equation

$$ {}_1Z_{11} = A_{11}\,F_{11} + A_{12}\,F_{21} + A_{13}\,F_{31} + \_\_\_\_\_\_ + A_1\,U_{11} $$

in which a potential source of variability is absent. The variability is indicated as being absent becuase this ability is constant for this circumscribed population. Assume further that the test has been standardized and found to be valid for this population. On the basis of this standardization and validation it was found further that the ability measured by the test was not as great for a second population. A factorial analysis of the data revealed the following equation

$$ {}_2Z_{12} = A_{11}\,F_{12} + A_{12}\,F_{22} + A_{13}\,F_{32} + A_{14}\,F_{42} + A_1\,U_{12} $$

for this second population. The presence of the fourth common factor for this population would mean an additional source of variation in the test scores. If the loading of this additional factor were substantial and the variability were not relevant to the validity of the test, then the test would be partially conjunctive for this population. That is, the individual level for that factor that was constant for the first population, would have to be attained before the test is compensatory. The fact that the source of variability found in the second group is not relevant to the validity of the test, means that the differences observed between the two groups could not be attributed to differences in the ability being measured by the test.

In terms of this discussion the problem of invariance consists of two aspects. One the one hand it would be important to determine the conditions under which factorial invariance would be expected. On the other, it would be important for

psychometric evaluation to determine the conditions under which invariance could not be observed, and the nature of the different regressions of tests on factors.

The invariance analysis applied to the two different age populations in this study is indicated by a lack of invariance. The exact nature of the differences observed could not be determined exactly. In Meredith's treatment (Meredith, 1964a; 1964b) this observed lack of invariance could be due either to differences in the test variance forthe two groups or to the differences of regression of variables on factors. Only in the latter case would an actual lack of invariance be indicated. The differences observed in the ranks of the matrices obtained for the two age groups would preclude an analysis in terms of Meredith's presentation.

The results of this study do suggest, however, the importance of investigating the factorial composition of a series of tests in different populations. It seems very doubtful that invariant factors would be obtained from successive samples selected as they were in this study. If invariant factors are not evident, then the differences observed should be systematically investigated. It seems evident from this study that such an investigation should begin with a battery of tests and a series of marker variables which could help to identify the important factors and complete test compositions in a specified population. The communality for a particular test should

approach the reliability for that test. This would be necessary to provide a basis for evaluating the appropriateness of the psychometric compensatory model for each test over different populations. The tests could then be administered to successive samples from the same age range until the criterion for invariant factors had been achieved. The tests would also be administered to samples from a different age population using the same or different marker variables depending on the differences observed in test composition. Comparisons between these matrices, or an average of these matrices, should allow a determination of the relationship between the factors observed in the different populations. An integrated study of successive age groups would provide evidence concerning the important sources of variability for a particular test battery over the age range of interest.

Such an integrated study could have important theoretical implications insofar as ontogenetic changes of constructs such as intelligence are concerned. Further evidence concerning the differentiation and constriction theory of intelligence (Garrett, Bryan, & Peel, 1935; Garrett, 1964; Balinsky, 1941) could be obtained. Evidence concerning the appropriateness of such a theory could not be obtained from the studies reported in the literature (Balinsky, 1941; Cohen, 1957; Berger, et al., 1964; Green & Berkowitz, 1964) since all of the relevant sources of variability were not identified. Replications using an

augmented test battery, such as that used by Davis (1956), and employing the methods outlined above, would be more appropriate for deriving theoretical conclusions.

The results of the factor score analysis indicated that for ten of the twelve factors extracted systematic changes over age were not evident. On the basis of this evidence one could conclude that the tests with substantial projections on these factors would be more valid as instruments for measuring brain damage as contrasted with the normal aging process. Tests having substantial populations on the Perceptual-Motor Speed Factor and the Perceptual Resolution Factor, on the other hand, would not be as appropriate as measuring instruments since a misclassification for older persons would be possible.

The differential decline of the three interpreted factors seems reasonable in terms of present knowledge of the aging process (Birren, 1964). The significant decline observed on factor scores of Factors II and III could suggest that aging affects input and output sources of variance; that is, processes which are closely associated with perception and response to a particular perception. On the other hand, factor scores for Factor I, which was interpreted as Perceptual Organization, did not decline. This might suggest that the ability associated with the organization of perceptual information is not as greatly affected by aging as are the input and output factors.

The fact that a differential decline was observed, in the

sense that a significant decline was indicated for factor scores on one factor but not for others, might suggest the usefulness of the distinction between brain damage and the aging process. Studies concerned with comparisons of test scores for brain damaged and the older person (Reitan, 1955; Reed and Reitan, 1962) have suggested a similarity between brain damage and aging. If this were the case then it would seem reasonable to assume that all the tests with high validities for brain damage would indicate a decline as a function of age. Similar considerations would seem reasonable for factor scores, providing that a large proportion of the observed variance for a test is accounted for by a single factor. This would seem to be the case for at least some of the tests loading Factors I and II. The differential decline determined for the factor scores for Factors I and II would suggest that some differences between normal aging and brain damage are evident.

The different declines observed for the factor scores of the factors extracted would also suggest that certain of the tests would be psychometrically more efficient for older age groups. By a psychometrically efficient brain damage test is meant one which discriminates between normals and brain damaged persons. In this sense a test loading highly on Factor I would be more efficient for older age groups than a test loading Factor III. If the tests loading the two factors have equal validity for brain damage it would be reasonable to select a test

with a high loading on Factor I for an older person since a large part of the variance observed in test scores is not systematically associated with age. A low score on a test with substantial loading on Factor III, on the other hand, could be attributed to the aging process.

SUMMARY

Three aspects of factor analyses of brain damage tests administered to normal populations were studied. The first concerned the determination of the factorial composition of the comprehension battery of brain damage tests for a sample of 100 normal individuals between the ages of 16-70. In this analysis twelve factors were extracted but only three could be interpreted. The first three factors were interpreted as Perceptual Organization, Perceptual-Motor Speed, and Perceptual Resolution. It was suggested that the battery be augmented with tests that would allow identification of the other factors retained.

The second analysis consisted of a test for factorial invariance for the data obtained in the 16-35 and 36-70 age groups. Thirteen factors were extracted for the former group and twelve for the latter. The index of relationship for the two analyses indicated a lack of invariance for the factor matrices. The implications of this result for psychometric evaluation was discussed.

The third aspect concerned the factor score changes as a function of age. The determination of factor scores was based on the data obtained for the 16-70 age group. A significant decline was observed for the factor scores of two of the factors, Perceptual-Motor Speed and Perceptual Resolution.

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APPENDICES

APPENDIX A

Raw Score Means and Standard Deviations For the Different Age Groups

	16-70		16-35		36-70	
Test	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
1	32.31	3.13	33.36	2.17	31.26	3.56
2	30.86	5.99	32.52	4.13	29.20	7.01
3	23.69	11.29	28.94	10.16	18.44	9.82
4	93.15	5.04	94.60	3.87	91.70	5.62
5	4.00	0.94	3.99	1.01	4.01	0.87
6	60.00	23.86	67.68	22.71	52.32	22.48
7	3.83	1.36	4.18	1.13	3.48	1.49
8	18.13	1.62	18.23	1.38	18.04	1.83
9	3.13	1.43	3.62	1.38	2.65	1.30
10	63.07	15.76	68.38	14.88	57.76	14.80
11	40.56	3.73	41.81	3.39	39.32	3.63
12	1.83	1.11	2.08	1.26	1.58	0.87
13	17.72	1.34	18.01	0.89	17.44	1.62
14	41.15	4.16	43.14	2.15	39.16	4.69
15	26.59	2.88	27.28	2.32	25.90	3.20
16	69.71	30.71	56.47	19.95	82.95	33.74
17	7.02	1.58	7.48	1.49	6.56	1.54
18	4.53	2.42	5.66	2.10	3.40	2.18
19	98.38	34.69	84.21	19.78	112.56	40.17
20	26.26	2.30	27.19	1.57	25.33	2.53
21	55.07	2.54	55.34	2.39	54.80	2.65
22	161.43	28.45	172.90	22.27	149.96	29.31
23	23.93	14.16	22.08	13.64	25.78	14.43
24	100.00	17.36	105.74	15.00	94.26	17.66
25	51.29	45.73	55.08	49.03	47.50	41.82
26	5.70	2.59	5.33	1.96	6.07	3.05
27	42.41	4.62	43.72	3.77	41.10	5.00
28	36.89	6.58	39.06	6.16	34.72	6.26
29	94.00	20.08	94.42	21.64	93.58	18.37
30	10.64	3.59	11.20	3.84	10.08	3.23
31	30.61	14.36	28.41	13.13	32.81	15.18
32	7.26	4.68	6.15	4.88	8.39	4.19
33	0.26	0.07	0.24	0.05	0.28	0.08
34	0.30	0.05	0.28	0.03	0.33	0.06
35	38.67	16.60	24.60	5.58	52.74	11.13

APPENDIX B1

16-70 Age Group Product-Moment Correlations for the Thirty-Five Variables

	1	2	3	4	5	6	7	8	9
1									
2	.556								
3	.175	.117							
4	.095	.091	.313						
5	-.077	-.005	.152	.059					
6	.052	.002	.319	.221	.057				
7	.139	.042	.174	.018	.000	-.001			
8	.224	.255	.036	.115	-.043	.048	-.014		
9	.273	.272	.124	.276	.051	.029	.066	.233	
10	.253	.156	.242	.058	-.114	.162	-.068	.239	.277
11	.007	.097	.306	.267	.049	.191	.144	.240	.180
12	-.023	-.120	.090	.064	-.039	.121	-.012	.028	.051
13	.507	.264	.030	-.034	-.040	.008	.081	.056	.178
14	.506	.278	.341	.141	-.014	.252	.100	.210	.201
15	.226	.310	.245	.143	-.103	-.039	.178	.013	.217
16	-.284	-.136	-.259	-.158	.025	-.262	.027	-.160	-.129
17	.367	.309	.125	.292	-.086	.209	.011	.159	.221
18	.395	.339	.243	.244	-.121	.209	.145	.242	.234
19	-.301	-.196	-.314	-.111	-.041	-.177	.040	-.184	-.289
20	.399	.318	.184	.131	.098	.163	.145	.282	.231
21	.162	.301	.044	.152	-.025	.086	-.020	.180	.274
22	.468	.303	.160	.199	-.006	.238	.101	.207	.429
23	-.080	-.005	-.303	-.121	-.156	-.107	.124	-.049	-.132
24	.397	.313	.291	.025	.082	.077	.052	.062	.233
25	-.221	-.010	.100	.035	-.125	-.016	-.158	.000	-.076
26	.057	.026	-.154	-.190	-.028	-.095	-.029	-.014	-.243
27	.162	.022	.311	.007	.091	.050	-.129	-.061	.160
28	.276	.134	.366	.200	.145	.176	.096	.110	.400
29	.106	.249	.095	.044	.004	-.036	.024	-.004	-.026
30	.086	.150	.185	.204	.023	.228	-.082	.086	.021
31	.007	.022	-.147	.024	-.238	-.153	.062	-.014	-.177
32	-.130	-.186	-.192	-.106	-.173	-.043	-.084	-.013	.000
33	-.240	-.264	-.053	.094	.130	.142	.090	-.027	-.126
34	-.223	-.174	-.333	-.129	.070	-.058	-.023	.017	-.248
35	-.281	-.173	-.553	.402	-.018	-.363	-.138	-.125	-.345

APPENDIX B1 (Cont'd)

	10	11	12	13	14	15	16	17	18
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11	.127								
12	.157	.006							
13	.177	-.073	.010						
14	.380	.159	.162	.464					
15	.176	.120	.076	.121	.172				
16	-.316	-.227	-.096	-.348	-.585	-.204			
17	.342	.120	-.089	.208	.429	.171	-.418		
18	.341	.186	.049	.267	.498	.212	-.462	.676	
19	-.431	-.113	-.131	-.432	-.524	-.371	.502	-.297	-.374
20	.239	.108	-.032	.331	.473	.026	-.413	.335	.444
21	.050	-.052	-.026	-.025	.110	.219	-.014	.082	.126
22	.320	.022	.042	.412	.451	.146	-.345	.329	.414
23	.010	-.159	-.062	-.193	-.159	-.071	.283	-.184	-.243
24	.358	.058	.022	.270	.447	.207	-.401	.281	.317
25	.145	.119	.044	-.170	-.079	-.009	-.070	-.001	-.001
26	.020	-.091	.112	.044	-.171	-.075	.134	.028	-.162
27	.336	.033	.121	.246	.303	.128	-.215	.056	.098
28	.387	.047	.032	.363	.375	.326	-.320	.241	.269
29	.123	-.125	.096	-.005	-.029	.161	.056	.027	-.039
30	.155	.183	.276	.117	.249	.201	-.384	.172	.213
31	-.181	-.117	.138	-.089	-.078	-.021	.096	-.050	-.087
32	-.080	-.078	-.021	-.166	-.084	-.107	.151	-.119	-.278
33	-.260	.017	-.011	-.156	-.226	-.335	.241	-.243	-.228
34	-.184	-.284	-.086	-.211	-.194	-.211	.142	-.083	-.199
35	-.449	-.401	-.274	-.167	-.453	-.204	.422	-.331	-.509

APPENDIX B1 (Cont'd)

	19	20	21	22	23	24	25	26	27
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20	-.242								
21	-.216	.067							
22	-.290	.470	.190						
23	.189	-.165	.005	-.107					
24	-.448	.213	.184	.379	-.130				
25	-.097	-.146	.066	-.058	-.130	.137			
26	.162	-.053	-.163	-.060	.012	.066	.200		
27	-.424	.019	.066	.208	.013	.392	.042	-.133	
28	-.485	.268	-.001	.353	-.089	.420	-.112	-.139	.473
29	.004	-.020	-.075	.072	.033	.074	.130	.110	-.031
30	-.251	.190	-.066	.130	-.190	.127	.146	-.124	.096
31	.076	-.050	.081	-.203	-.001	-.192	.001	-.053	-.282
32	.124	-.225	-.097	-.200	.069	-.177	-.041	.046	-.172
33	.426	-.133	-.140	-.171	-.077	-.252	-.047	.114	-.268
34	.411	-.023	.005	-.174	.184	-.199	-.048	.160	-.337
35	.445	-.361	-.041	-.415	.211	-.344	-.122	.131	-.300

APPENDIX B1 (Cont'd)

	28	29	30	31	32	33	34	35
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29	.082							
30	.158	.170						
31	-.221	.039	-.125					
32	-.092	-.050	-.273	.317				
33	-.204	.069	-.242	.120	.126			
34	-.261	.088	-.171	.056	.085	.451		
35	-.462	-.014	-.213	.252	.189	.194	.445	

APPENDIX B2

16-70 Age Group Unrotated Alpha Factors

	I	II	III	IV	V	VI	VII
1	.582	-.463	.134	-.100	-.055	.071	-.067
2	.448	-.417	.150	.117	-.041	.329	.149
3	.508	.438	-.044	.046	-.143	.226	-.114
4	.327	.295	.253	.203	-.083	.049	.137
5	.032	.257	.025	-.378	-.183	.146	.096
6	.302	.335	.156	-.062	.134	-.109	.046
7	.117	-.006	.239	-.034	-.263	.178	-.267
8	.279	-.102	.261	.102	.125	-.080	.241
9	.476	-.035	.077	.081	-.305	-.074	.329
10	.533	-.053	-.215	.053	.262	-.070	.220
11	.299	.396	.185	.246	-.029	.038	-.016
12	.131	.239	-.182	.003	.200	-.108	-.043
13	.471	-.340	-.070	-.307	-.029	-.088	-.256
14	.715	-.098	.051	-.111	.106	-.221	-.155
15	.376	-.116	-.150	.275	-.209	.255	-.077
16	-.634	-.060	-.012	.027	-.264	.180	.213
17	.550	-.134	.230	.089	.238	-.036	-.017
18	.680	-.078	.269	.099	.155	-.069	-.114
19	-.682	.035	.330	-.091	.009	.130	.059
20	.534	-.142	.348	-.223	.067	-.070	-.037
21	.220	-.172	.092	.267	-.184	.005	.420
22	.617	-.163	.129	-.186	.004	-.038	.145
23	-.279	-.227	-.140	.024	-.022	-.105	.305
24	.565	-.131	-.244	-.149	.066	.149	.035
25	.005	.178	-.225	.291	.427	.253	.069
26	-.171	-.164	-.058	-.161	.393	.266	-.051
27	.406	.088	-.573	-.174	-.120	-.100	.112
28	.611	.040	-.222	-.179	-.236	-.008	.085
29	.048	-.136	-.023	.028	.110	.523	.095
30	.383	.239	-.082	.112	.282	.147	-.128
31	-.222	-.267	.183	.424	-.044	-.082	-.260
32	-.294	-.088	.027	.230	.009	-.297	-.019
33	-.367	.340	.431	-.328	.068	.098	.114
34	-.420	-.110	.312	-.249	.229	.044	.173
35	-.734	-.378	.011	-.096	-.018	.005	-.006
Associated Eigenvalues	12.496	3.672	3.147	2.621	2.427	2.112	1.978

APPENDIX B2 (Cont'd)

	VIII	IX	X	XI	XII	h^2
1	.105	.018	.055	-.028	.006	.608
2	-.108	.086	.045	-.011	.071	.569
3	.101	-.081	-.132	.034	-.050	.577
4	-.022	-.147	-.007	-.003	.003	.349
5	-.174	.072	-.133	-.078	.109	.345
6	.020	-.186	-.012	.002	-.085	.306
7	.203	.036	.094	.014	-.125	.312
8	.042	.192	.039	-.098	.187	.332
9	.131	.125	-.001	-.113	.093	.501
10	.223	-.035	.026	.118	.054	.527
11	.069	.322	.056	.139	.170	.503
12	.193	.003	.389	-.368	-.130	.502
13	.023	.040	.001	-.122	.074	.534
14	.027	-.107	-.045	-.071	-.016	.640
15	.029	-.102	.118	-.084	-.056	.403
16	.167	.062	.113	.048	-.051	.603
17	-.073	-.091	-.102	.241	-.087	.529
18	-.106	.013	.052	.229	-.203	.700
19	.067	.006	.159	.170	-.056	.666
20	-.088	.052	.035	.008	.084	.506
21	-.226	.041	.159	-.352	-.461	.782
22	.069	-.030	.052	-.076	-.078	.496
23	.043	-.166	.229	.207	-.027	.379
24	.045	.067	-.218	-.003	-.129	.517
25	-.007	.170	-.223	-.030	-.071	.503
26	.253	.184	.002	-.039	-.054	.415
27	-.004	-.024	-.076	.081	-.027	.582
28	.177	-.199	-.085	.023	.144	.619
29	.088	-.342	-.027	-.003	.199	.483
30	-.393	-.196	.334	-.220	.265	.764
31	.007	-.153	-.191	-.106	.050	.483
32	.374	-.121	-.237	-.126	.168	.491
33	.270	-.092	-.121	-.134	-.030	.686
34	-.027	-.202	-.053	-.088	-.080	.491
35	-.243	-.015	-.099	-.142	.091	.789
Associated Eigenvalues	1.571	1.400	1.322	1.173	1.091	

APPENDIX B3

16-70 Age Group Varimax Factors

	I	II	III	IV	V	VI	VII
1	.608	.179	-.143	-.143	.091	.004	.215
2	.384	-.000	-.068	-.244	.233	.137	.334
3	.106	.345	.533	-.098	-.006	.119	-.064
4	.109	.006	.530	.001	.135	.011	.133
5	-.116	.158	.038	.222	-.006	.351	.036
6	.226	.092	.418	.184	-.000	.049	-.053
7	.087	-.060	.085	-.010	-.025	.011	-.014
8	.254	-.050	.075	.023	.068	-.037	.494
9	.150	.328	.183	-.092	.243	.001	.478
10	.360	.422	.157	-.107	-.051	-.029	.195
11	.014	-.027	.479	-.175	-.170	.092	.335
12	-.010	.088	.072	-.013	.000	.029	.011
13	.523	.278	-.286	-.113	-.070	.029	.036
14	.684	.298	.140	-.090	.014	-.058	.035
15	.106	.164	.120	-.411	.189	-.014	.017
16	-.608	-.171	-.218	.150	.053	.000	.036
17	.635	.019	.263	-.083	.045	-.006	.032
18	.712	-.014	.331	-.198	.077	.105	.040
19	-.386	-.500	-.104	.366	-.138	.062	-.060
20	.615	.015	.072	.062	-.023	.152	.232
21	.085	.022	.062	-.066	.864	.006	.130
22	.547	.278	.087	.038	.148	.134	.205
23	-.176	-.017	-.173	.011	.010	-.012	-.014
24	.389	.484	-.024	-.108	.149	.140	.003
25	-.108	.010	.125	-.100	.068	-.017	-.017
26	.013	-.061	-.318	.199	-.144	.033	.011
27	.068	.678	.020	-.217	.011	.179	-.100
28	.266	.649	.186	-.080	-.031	.037	.083
29	-.002	.044	.011	.051	-.043	.002	-.017
30	.221	-.108	.263	-.303	-.119	.252	-.005
31	-.016	-.331	-.071	-.155	.096	-.540	-.088
32	-.190	.007	-.071	.144	-.070	-.641	.069
33	-.229	-.172	.133	.740	-.076	-.005	.009
34	-.047	-.320	-.187	.540	.073	-.010	-.099
35	-.349	-.390	-.602	.149	.063	-.112	-.136
Sums of Squares	4.228	2.562	2.119	1.741	1.110	1.063	1.002

APPENDIX B3 (Cont'd)

	VIII	IX	X	XI	XII
1	.185	-.080	-.016	.265	-.011
2	.363	.043	-.153	.123	-.018
3	.108	.072	.032	.202	.274
4	.100	-.085	.012	.015	.055
5	.016	-.151	-.115	-.035	.307
6	-.044	-.026	.148	-.078	.043
7	.035	-.094	-.000	.523	.092
8	.006	.035	.030	-.084	-.002
9	-.002	-.175	-.011	.106	-.005
10	.084	.225	.135	-.132	-.221
11	-.150	.135	-.012	.108	.160
12	-.075	.075	.690	.014	-.003
13	.021	-.148	.083	.128	.189
14	-.031	-.093	.151	-.000	.135
15	.292	-.019	.096	.224	.016
16	.046	-.034	-.119	.201	-.267
17	.053	.121	-.146	-.039	-.076
18	-.072	.072	-.038	.102	-.052
19	-.010	-.012	-.127	.149	-.239
20	.008	-.147	-.025	.055	.123
21	-.028	.005	-.013	-.031	-.014
22	.063	-.084	.071	.102	-.052
23	.050	-.109	-.032	-.120	-.536
24	.094	.227	-.041	.051	.114
25	.080	.629	.033	-.214	.110
26	.118	.459	.108	.109	-.033
27	-.073	-.011	.048	-.140	-.021
28	.169	-.201	.013	.067	.052
29	.676	.111	-.061	.017	-.041
30	.331	-.064	.413	-.349	.243
31	.082	-.052	-.139	.037	.077
32	-.068	-.014	-.010	-.044	-.044
33	.012	-.001	.032	.142	.108
34	.124	-.015	-.040	-.117	-.116
35	.058	-.125	-.240	-.185	.001
Sums of Squares	.991	.985	.910	.902	.878

APPENDIX B4

16-70 Age Group

Varimax Transformation Matrix

.696	.446	.349	-.272	.104	.145	.216	.087	-.010	.102	.073	.140
-.382	.083	.723	.184	-.188	.228	-.106	-.219	.059	.223	-.093	.287
.319	-.621	.285	.435	.069	-.069	.292	-.004	-.199	-.186	.258	.082
-.182	-.293	.374	-.587	.241	-.493	.145	.074	.226	-.009	-.059	-.123
.346	-.236	-.046	.218	-.225	-.036	-.067	.073	.642	.283	-.462	-.085
-.185	-.078	.014	-.033	.058	.383	-.024	.711	.371	-.137	.343	.169
-.202	.222	.106	.301	.423	.198	.483	.108	.022	-.100	-.356	-.455
-.091	.352	.033	.305	-.250	-.469	.207	.027	.238	.218	.533	-.243
-.096	-.077	-.249	-.192	-.029	.280	.518	-.535	.394	-.088	.185	.233
-.024	-.283	-.020	-.248	-.205	.367	.140	.055	-.261	.609	.163	-.439
.100	.016	.233	-.138	-.442	.193	-.163	-.136	.110	-.596	.062	-.517
-.109	.042	-.056	-.096	-.598	-.148	..489	.328	-.253	-.123	-.331	.243

APPENDIX C

Correlation Matrices

16-35 and 36-70 Age Groups*

	1	2	3	4	5	6	7	8	9
1		.573	.065	-.019	-.342	-.090	.044	.158	.121
2	.341		-.022	-.059	-.249	-.161	-.042	.236	.189
3	-.041	-.003		.170	.231	.088	.092	-.011	-.065
4	.041	.187	.280		.051	.101	-.064	.011	.174
5	.287	.359	.133	.086		.243	.005	-.139	.092
6	-.026	.004	.310	.206	-.091		-.094	.005	.059
7	.088	-.007	.029	-.052	.001	-.091		.022	-.135
8	.351	.284	.036	.280	.067	.066	-.124		.186
9	.286	.229	-.019	.241	.031	-.230	.115	.286	
10	-.112	-.052	-.084	-.017	-.154	.145	-.088	.096	.201
11	-.049	-.005	.143	.099	.066	.247	.285	.177	.120
12	-.234	-.511	.093	.125	-.030	.043	-.042	-.113	-.080
13	.321	.280	-.137	-.226	.084	-.241	-.142	.056	.236
14	.173	.309	.073	.136	.144	.297	-.241	.300	.347
15	-.068	.020	-.002	.148	-.086	-.006	.241	.127	.052
16	-.052	-.154	-.000	-.198	.058	-.034	.188	-.154	-.042
17	.201	.298	-.199	.197	-.012	.115	-.040	.093	.245
18	.163	.191	-.104	.109	-.198	.150	-.118	.037	.052
19	-.159	-.187	-.094	-.292	.007	-.087	.085	-.055	-.291
20	.284	.156	-.052	.062	.235	-.027	-.279	.144	.199
21	.104	.173	.008	.220	.068	.103	.267	.268	.239
22	.285	.376	.044	-.005	.086	-.015	-.168	.264	.265
23	.006	.053	-.227	-.021	-.208	-.177	-.082	.200	-.073
24	.078	.176	.103	-.016	.271	-.100	.109	-.096	.105
25	-.489	.005	.049	.065	-.128	-.097	-.060	-.203	-.123
26	-.024	-.189	-.155	-.313	.083	-.085	-.021	-.153	-.234
27	.215	.101	.083	.017	.181	-.111	-.106	.009	.272
28	.250	.416	.044	.300	.062	.031	-.022	.127	.337
29	-.056	.230	.098	.151	.097	.009	-.192	-.047	.111
30	-.141	.014	.223	.330	.060	.351	-.092	-.115	-.054
31	-.133	-.009	-.049	-.041	-.180	-.021	-.004	-.048	-.069
32	-.038	-.030	-.134	.001	-.235	-.057	.191	.046	.219
33	.071	-.051	.112	-.076	.096	.093	.056	-.120	-.039
34	.093	.216	-.027	-.155	.133	-.015	-.074	.133	-.104
35	.065	.072	-.125	-.368	.243	-.172	.008	.012	.009

*16-35 Age group correlations appear in the lower triangle and the 36-70 age group correlations in the upper triangle.

APPENDIX C (Cont'd)

	10	11	12	13	14	15	16	17	18
1	.330	-.162	-.013	.524	.490	.260	-.204	.368	.370
2	.144	.009	.039	.199	.136	.366	.029	.231	.289
3	.295	.217	-.179	-.053	.206	.278	-.122	.176	.169
4	-.063	.251	-.125	-.056	-.038	.045	.024	.253	.147
5	-.075	.045	-.051	-.119	-.093	-.123	.001	-.172	-.057
6	-.028	-.051	.071	.027	.046	-.218	-.217	.139	-.006
7	-.236	-.093	-.116	.099	.046	.061	.146	-.091	.138
8	.340	.276	.157	.041	.183	-.071	-.149	.191	.396
9	.164	-.030	.054	-.054	-.096	.227	.061	.023	.130
10		-.014	-.061	.155	.341	.168	-.308	.329	.290
11.	.049		.129	-.148	-.063	.062	-.083	-.072	.001
12	.195	-.228		.031	.101	-.206	.129	-.128	-.081
13	.054	-.189	-.139		.490	.136	-.325	.078	.162
14	.156	.143	.037	.156		.038	-.556	.373	.427
15	.021	.019	.246	-.079	.160		-.145	.182	.252
16	-.040	-.131	-.150	-.185	-.205	-.047		-.343	-.325
17	.211	.134	-.197	.323	.348	.007	-.359		.607
18	.149	.074	-.053	.276	.258	-.075	-.355	.673	
19	-.280	.065	-.124	-.349	-.260	-.081	.406	-.306	-.275
20	.137	-.061	-.040	.343	.367	-.206	-.259	.256	.195
21	.060	-.056	-.045	-.139	.131	.109	.155	.027	.027
22	.081	-.100	-.156	.313	.466	-.011	-.046	.188	.354
23	.270	-.118	-.057	-.075	-.170	.211	.205	-.099	-.145
24	-.044	.109	-.201	.115	-.024	-.099	-.157	-.058	-.128
25	.145	.093	-.138	-.160	-.223	-.038	-.072	-.064	.050
26	.202	-.238	.118	-.025	-.176	-.185	-.083	-.068	-.080
27	.131	-.076	.135	.181	.190	.050	-.027	.067	-.037
28	.147	-.164	-.083	.317	.141	.199	-.064	.274	.051
29	.149	.011	-.150	.059	-.009	.088	.182	-.091	-.062
30	.098	.170	.312	.035	.219	.308	-.324	.137	.130
31	-.142	-.033	.010	-.148	-.116	-.049	.132	-.088	-.100
32	-.051	.154	-.042	-.330	.053	.000	.061	-.052	-.160
33	-.059	.111	.045	-.069	.036	-.214	.251	-.278	-.280
34	.277	-.146	.052	.076	.131	-.093	.131	-.073	-.187
35	-.218	.027	-.181	.153	-.017	-.055	-.025	-.206	-.300

APPENDIX C (Cont'd)

	19	20	21	22	23	24	25	26	27
1	-.202	.314	.156	.436	-.066	.454	-.129	.167	.010
2	-.068	.263	.353	.149	.022	.284	-.064	.167	-.135
3	-.199	.025	-.020	-.096	-.324	.221	.096	-.067	.316
4	.110	-.003	.072	.147	-.132	-.114	-.031	-.088	-.132
5	-.089	.033	-.120	-.078	-.106	-.083	-.120	-.116	.031
6	-.041	.081	.012	.234	.034	.025	.016	-.034	.004
7	.198	.200	-.265	.093	-.105	-.130	-.307	.023	-.281
8	-.225	.349	.113	.165	-.214	.135	.170	.065	-.131
9	-.132	.055	.269	.407	-.115	.165	-.096	-.203	-.088
10	-.401	.114	-.025	.318	-.143	.553	.101	-.008	.374
11	.012	-.016	-.125	-.154	-.129	-.192	.103	.069	-.065
12	.001	-.247	-.064	.052	-.005	.117	.306	.202	-.011
13	-.398	.251	-.007	.392	-.229	.271	-.236	.113	.208
14	-.444	.347	.046	.281	-.094	.512	-.109	-.102	.208
15	-.395	-.023	.261	.092	-.216	.288	-.026	.024	.073
16	.394	-.301	-.028	-.282	.291	-.384	-.018	.143	-.144
17	-.170	.253	.076	.284	-.204	.422	.017	.163	-.098
18	-.221	.400	.138	.227	-.263	.460	-.152	-.130	-.044
19		-.006	-.191	-.056	.221	-.462	-.105	.137	-.370
20	-.376		-.004	.337	-.098	.105	-.300	-.025	-.241
21	-.212	.081		.113	.004	.215	.138	-.138	.021
22	-.410	.433	.235		-.059	.373	-.288	.022	-.006
23	.017	-.174	.037	-.062		-.131	-.186	-.036	.061
24	-.166	.069	.084	.149	-.045		.037	.099	.421
25	-.023	-.079	-.017	.106	-.062	.199		.394	.113
26	.045	.079	-.177	-.052	.040	.165	-.000		-.194
27	-.324	.169	.062	.303	.042	.187	-.086	.101	
28	-.214	.147	.090	.172	.184	.195	-.119	-.079	.400
29	.039	.029	-.165	.153	.151	.048	.158	-.008	.050
30	-.305	.131	-.047	-.058	-.061	.042	.160	-.095	.090
31	.398	-.289	-.037	-.242	-.050	-.106	.029	-.176	-.151
32	.269	-.287	-.056	-.311	.085	-.155	-.096	-.152	-.242
33	.147	.025	-.065	-.122	-.165	-.166	-.223	.104	-.160
34	.021	-.040	.072	.084	.404	-.018	-.104	.316	.079
35	-.001	-.021	.115	-.158	-.042	.294	-.150	-.094	.250

APPENDIX C (Cont'd)

	28	29	30	31	32	33	34	35
1	.155	.229	.169	.167	-.073	-.258	-.163	-.011
2	-.164	.294	.193	.108	-.208	-.263	-.165	.137
3	.469	.095	.014	-.120	-.047	.066	-.266	-.480
4	-.004	-.047	.046	.090	-.076	.296	.054	-.296
5	.266	-.121	-.024	-.311	-.106	.168	.036	-.227
6	.125	-.109	-.002	-.189	.145	.358	.163	-.200
7	.038	.208	-.166	.173	-.216	.223	.178	.214
8	.076	.031	.253	.023	-.039	.040	.007	-.202
9	.311	-.219	-.010	-.196	-.073	-.044	-.140	-.191
10	.473	.095	.125	-.137	.059	-.278	-.247	-.410
11	.014	-.309	.109	-.101	-.164	.122	-.183	-.371
12	.009	-.025	.147	-.264	.160	064	-.026	-.194
13	.336	-.055	.131	-.018	-.002	-.118	-.207	-.009
14	.340	-.070	.223	.038	.030	-.164	-.021	-.122
15	.325	.231	.063	.058	-.100	-.326	-.138	.017
16	-.303	.002	-.413	-.015	.058	.108	-.116	.160
17	.054	.151	.132	.063	-.056	-.128	.119	-.160
18	.220	-.049	.197	.051	-.237	-.033	.107	-.233
19	-.531	.001	-.180	-.148	-.102	.430	.368	.254
20	.168	-.078	.161	.175	-.055	-.052	.262	-.045
21	-.153	.012	-.126	.205	-.095	-.149	.050	.090
22	.320	-.001	.197	-.100	.049	-.051	-.043	-.151
23	-.266	-.091	-.301	.001	-.009	-.092	-.002	.314
24	.480	.097	.123	-.185	-.063	-.191	-.096	-.311
25	-.182	.090	.101	-.000	.051	.117	.048	-.081
26	-.114	.215	-.119	-.023	.138	.070	.031	.054
27	.439	-.118	.027	-.318	-.004	-.232	-.401	-.258
28		-.080	.086	-.294	.156	-.117	-.286	-.544
29	.218		-.035	.133	.135	.068	.145	.224
30	.140	.315		-.019	-.232	-.228	-.097	-.127
31	-.052	-.044	-.188		.008	-.271	-.010	.360
32	-.164	-.178	-.255	.581		.042	-.067	-.072
33	-.154	.097	-.213	.015	.109		.391	-.046
34	.093	.068	-.159	-.013	.050	.380		.252
35	-.055	-.362	-.237	-.037	.054	-.094	-.073	

APPENDIX D1

16-35 Age Group Unrotated Alpha Factors

	I	II	III	IV	V	VI	VII
1	-.463	-.369	-.298	.040	.055	.142	-.118
2	-.536	-.186	-.368	-.007	.001	-.038	.416
3	-.050	.245	-.105	-.471	.030	.089	.016
4	-.280	.543	-.329	-.189	-.114	-.005	.072
5	-.256	-.298	-.106	-.450	.101	.030	.006
6	-.062	.476	-.104	-.209	.046	.400	-.018
7	.195	-.004	-.348	-.080	.002	-.296	-.174
8	-.339	.007	-.431	.138	-.163	.140	-.071
9	-.481	-.038	-.368	.136	-.110	-.130	-.069
10	-.217	.153	.266	.192	-.406	.146	.024
11	.007	.289	-.309	-.145	.260	.058	.103
12	.114	.325	.317	-.125	-.291	.102	-.593
13	-.507	-.296	.188	.190	.116	-.044	.039
14	-.554	.162	-.207	.024	.007	.326	-.138
15	-.057	.320	-.147	.023	-.328	-.279	-.174
16	.377	-.281	-.223	-.143	-.312	.066	.150
17	-.529	.198	.011	.478	.215	.057	.083
18	-.423	.302	.148	.484	.312	.132	.108
19	.636	-.179	-.200	.021	.034	.083	.184
20	-.562	-.128	.182	-.016	.172	.218	-.051
21	-.216	.022	-.344	-.039	-.150	-.105	-.164
22	-.640	-.099	.017	.025	-.011	.081	.139
23	.061	-.113	-.002	.279	-.673	-.154	.122
24	-.223	-.202	.063	-.330	.122	-.366	.131
25	.118	.273	.281	-.066	.075	-.312	.471
26	.078	-.309	.498	-.050	-.123	.137	-.047
27	-.418	-.154	.102	-.178	-.194	-.193	-.164
28	-.503	-.024	-.107	-.016	-.335	-.223	.125
29	-.123	.098	.085	-.235	-.317	.054	.578
30	-.269	.605	.220	-.292	-.061	-.076	.007
31	.387	.039	-.308	.214	.024	-.013	.127
32	.407	.033	-.491	.359	-.018	.060	-.040
33	.217	-.227	-.106	-.258	-.042	.553	-.002
34	-.041	-.356	.032	-.036	-.505	.382	.078
35	.001	-.479	-.143	-.132	.243	-.414	-.349
Associated Eigenvalues	7.313	4.130	3.526	3.271	2.975	2.720	2.292

APPENDIX D1 (Cont'd)

	VIII	IX	X	XI	XII	XIII	h^2
1	.148	-.031	-.199	-.085	-.104	-.092	.568
2	.047	-.113	-.100	.141	-.126	.085	.699
3	.021	.048	.058	-.001	-.060	.058	.317
4	.115	.064	.096	.041	-.387	-.333	.825
5	.053	.102	-.067	.058	-.038	-.097	.412
6	-.127	-.072	-.153	.135	-.077	.376	.658
7	-.293	-.121	-.328	-.571	-.111	.027	.830
8	-.113	.036	-.072	.317	.073	-.282	.575
9	-.038	-.026	.424	-.400	.166	-.191	.827
10	-.329	-.165	.134	-.098	.068	.039	.534
11	-.314	-.391	-.077	-.100	.340	-.086	.672
12	.175	.001	.180	-.044	-.092	-.068	.759
13	.245	-.028	-.022	-.113	.103	.081	.524
14	-.018	-.077	.167	.124	.235	.182	.640
15	.130	-.029	-.192	-.001	.159	.016	.424
16	-.012	.360	-.047	-.225	.136	.229	.669
17	-.006	-.217	-.133	-.134	-.136	.098	.714
18	-.043	.080	-.158	-.086	-.118	.125	.723
19	.145	-.048	-.077	.066	.055	.007	.556
20	-.018	.096	.104	.009	.054	-.162	.495
21	-.374	.306	-.038	.008	-.163	.064	.492
22	-.166	.380	.097	.015	.100	.084	.644
23	-.075	-.078	-.203	.229	.080	-.088	.705
24	-.213	-.198	.088	.023	-.117	.019	.477
25	-.348	.110	.229	.068	-.008	-.046	.689
26	-.173	-.211	-.057	-.032	-.203	-.083	.515
27	.060	-.038	.179	-.030	.011	.149	.402
28	.261	-.129	.020	-.102	-.194	.166	.604
29	.243	-.002	.016	-.143	.212	-.086	.657
30	.183	-.194	-.113	.028	.096	.019	.675
31	.193	-.073	.329	.067	-.201	.159	.530
32	-.026	-.314	.396	-.022	-.048	-.007	.801
33	.004	-.051	.060	-.233	.039	-.019	.546
34	-.183	-.214	-.008	.115	-.132	.096	.657
35	-.082	-.159	.086	.332	.231	.227	.874
Associated Eigenvalues	1.858	1.598	1.511	1.439	1.246	1.124	

APPENDIX D2

Varimax Transformation Matrix

16-35 Age Group

-.467	-.465	-.532	-.259	-.234	-.061	-.243	-.168	-.111	-.086	.202	-.148	.073
.293	-.048	-.006	-.281	-.379	-.210	-.287	.411	.471	.355	.000	-.037	.213
.214	.478	-.182	-.407	-.380	.233	.041	-.196	-.128	-.158	-.160	-.389	-.264
.590	-.352	.037	.050	.004	.112	-.459	-.252	-.438	.130	-.087	.132	-.061
.360	.009	-.190	.069	-.004	-.664	.160	-.170	.037	-.518	-.022	-.030	.251
-.019	.019	-.033	-.049	.364	.340	-.494	.065	.382	-.507	-.263	-.068	.147
-.028	-.041	-.063	.764	-.446	.113	-.117	.193	-.019	-.116	-.057	-.360	-.006
-.049	-.143	-.020	-.027	.424	-.379	-.097	.147	-.042	.217	-.239	-.592	-.407
-.269	.329	.082	.068	-.183	-.380	-.457	.025	-.061	-.104	-.111	.445	-.443
-.130	-.461	.585	-.242	-.320	-.020	.184	.067	-.041	-.313	-.348	-.027	-.090
-.026	-.080	-.440	.091	-.035	.049	.244	-.038	.081	.214	-.768	.289	.029
-.265	.226	.310	.041	-.046	-.154	-.219	-.511	-.036	.278	-.231	-.225	.513
.093	-.191	.048	.145	-.075	.029	.066	-.584	.629	.085	.138	.006	-.397

APPENDIX E1

36-70 Age Group   Unrotated Alpha Factors

	I	II	III	IV	V	IV	VII
1	-.628	.472	.045	.062	.135	.028	.104
2	-.376	.528	.096	.126	-.192	.178	.182
3	-.340	-.400	.012	-.041	-.329	-.479	.089
4	-.053	-.155	-.347	.054	-.335	.054	.221
5	.089	-.468	-.181	-.168	-.010	-.091	.060
6	-.032	-.323	-.302	.089	.292	.047	.138
7	.084	.245	-.369	-.201	-.007	-.385	-.047
8	-.369	.059	-.205	.379	-.157	.241	-.178
9	-.258	-.148	-.060	-.103	-.150	.481	.494
10	-.631	-.145	.219	.095	.050	-.054	.046
11	-.003	-.299	-.074	.227	-.482	.177	-.220
12	.040	-.138	.159	.489	.199	.229	-.051
13	-.540	.116	.032	-.111	.348	.007	-.116
14	-.651	.038	-.081	-.048	.303	-.028	-.301
15	-.409	.193	.219	-.142	-.368	-.218	.257
16	.571	.108	.199	.028	-.141	.062	.335
17	-.538	.187	-.271	.213	-.038	-.115	.107
18	-.617	.125	-.362	-.013	-.169	.019	-.023
19	.616	.174	-.360	.123	.007	.066	.129
20	-.374	.206	-.499	-.136	.093	.066	-.152
21	-.185	.237	.105	-.047	-.185	.285	.358
22	-.495	.056	-.252	-.022	.341	.250	.282
23	.342	.158	.168	-.185	.249	.247	.084
24	-.730	-.021	.183	.106	.211	-.064	.189
25	.074	-.093	.278	.684	-.151	-.095	-.077
26	.045	.196	.081	.507	.092	-.180	.063
27	-.278	-.403	.528	-.195	.144	-.075	-.040
28	-.600	-.536	.091	-.214	.142	-.224	.130
29	-.044	.371	.061	.202	.036	-.471	.207
30	-.368	-.033	-.064	.126	-.133	.202	-.437
31	.018	.540	-.018	-.153	-.200	-.079	-.211
32	.075	-.096	.170	.199	.375	-.129	.113
33	.332	-.262	-.539	.288	.086	-.166	.201
34	.224	.185	-.556	.127	.170	-.105	.021
35	.401	.668	.050	-.213	.166	-.038	-.071
Associated Eigenvalues	7.957	4.942	3.886	3.188	2.900	2.506	2.183

APPENDIX E1 (Cont'd)

	VIII	IX	X	XI	XII	h^2
1	.197	.041	-.150	-.182	.050	.752
2	.153	-.177	-.007	-.039	.014	.603
3	.014	-.014	-.156	-.019	.102	.659
4	-.097	.270	-.167	-.282	-.024	.505
5	.025	-.136	.152	.041	-.022	.344
6	-.184	.046	.040	-.076	.028	.355
7	.437	-.086	.078	.080	.176	.637
8	.091	.030	.053	.431	.091	.645
9	.149	.047	.265	.115	-.064	.713
10	-.041	-.013	-.219	.279	-.194	.649
11	.203	.098	-.134	-.057	.112	.543
12	.187	-.096	.121	-.032	.098	.449
13	.308	.158	.167	-.345	.223	.732
14	-.075	-.008	-.114	-.078	.267	.713
15	.035	-.021	.208	-.088	-.038	.576
16	.317	.006	-.149	.150	.096	.669
17	-.279	.020	-.276	-.060	-.146	.649
18	-.075	-.171	-.123	.126	.102	.633
19	.181	-.181	-.311	-.104	-.173	.788
20	.082	.059	-.032	.216	-.000	.543
21	-.484	-.028	.202	-.002	.317	.669
22	.178	.129	.023	-.111	-.185	.666
23	-.062	-.093	-.322	.050	.042	.455
24	-.099	-.315	-.088	.023	.084	.786
25	-.295	-.060	.152	-.016	.097	.720
26	.183	.032	-.047	-.057	.012	.389
27	-.114	-.188	-.181	-.099	.092	.684
28	.260	.094	.134	.157	-.015	.908
29	-.014	-.053	.116	.038	-.167	.496
30	.007	-.140	.230	-.233	-.392	.687
31	-.217	.436	.033	.051	.102	.658
32	-.062	.473	.033	.175	-.056	.516
33	.034	-.052	.006	-.111	.221	.693
34	-.286	-.221	.113	.083	.005	.606
35	-.103	-.109	.187	-.056	.011	.750
Associated Eigenvalues	2.047	1.539	1.466	1.270	1.080	

APPENDIX E2

36-70 Age Group

Varimax Transformation Matrix

-.499	-.508	-.442	.171	.060	-.289	-.182	-.324	-.089	-.180	-.026	-.052
-.680	.277	.197	-.397	-.098	.129	-.090	-.127	.367	.146	-.227	.081
.300	-.119	-.072	-.663	.323	-.421	-.091	-.076	-.066	.190	-.294	-.169
-.111	.236	-.138	.137	.861	.208	-.087	.072	.475	-.045	.196	-.162
-.073	.149	.425	.375	.099	-.168	.051	-.075	-.192	-.220	-.600	-.400
-.327	-.010	.003	-.153	.159	.140	.523	.098	-.695	.215	.039	.101
.091	.211	-.137	.196	-.009	-.280	.595	-.512	.314	.291	.092	-.060
.082	-.331	.350	-.255	.173	.163	.343	-.268	.162	-.612	.077	.209
-.099	-.139	.201	-.181	-.183	.083	.010	-.039	-.013	.032	.478	-.791
-.054	-.582	.101	.151	.092	.089	.265	.448	.391	.357	-.230	-.062
.190	-.038	-.436	-.086	-.110	.681	.055	-.262	-.015	-.008	-.399	-.239
.104	-.244	.423	.156	.149	.218	-.350	-.497	-.156	.474	.077	.179

APPENDIX F1

Factor I scores[1] for the Eight Age Groups

and Summary of Analysis of Variance

	16-20	21-25	26-30	31-35	36-45	46-55	56-65	66+
	54.9	39.0	66.0	56.5	45.6	34.4	42.6	32.6
	48.3	51.9	55.1	58.4	70.7	51.6	42.4	66.2
	56.2	52.5	49.6	52.7	45.6	74.6	44.8	56.1
	63.2	60.3	49.6	45.7	31.3	29.3	55.7	43.5
	57.5	59.1	39.2	66.7	56.2	44.3	54.2	56.1
	62.8	56.5	57.4	50.3	38.5	57.9	49.7	56.9
	60.0	54.6	51.1	43.5	48.1	48.1	54.1	46.3
	38.7	60.3	52.3	41.7	55.3	45.4	38.5	50.2
	38.9	62.3	45.4	63.0	51.9	59.8	51.7	46.4
	63.3	48.2	54.3	43.0	30.6	32.8	17.1	
	45.6	57.5	44.8		51.5	58.5	56.0	
	54.4		43.4		39.3	44.2	31.3	
	57.8		61.6		44.4	26.6		
	46.6				43.7	41.6		
	56.7				55.2			
	51.3							
Sums	856.4	602.2	669.9	521.7	708.0	649.1	538.2	454.3
Means	53.5	54.8	51.5	52.2	47.2	46.4	44.8	50.5

Summary of Analysis of Variance

Source	df	MS	F	p
Between	7	1,586,347	1.64	N.S.
Within	92	966,574		

[1]All factor scores were computed with a mean of 50 and a standard deviation of 10.

APPENDIX F2

Factor II Scores[1] for the Eight Age Groups and Summary of Analysis of Variance

	16-20	21-25	26-30	31-35	36-45	46-55	56-65	66+
	44.0	71.9	48.0	56.3	49.8	48.4	49.1	38.5
	55.8	51.5	56.9	52.3	43.1	61.5	38.4	10.0
	53.4	56.9	56.2	60.4	68.6	26.9	43.5	43.4
	55.3	57.9	56.4	37.2	48.7	49.6	43.4	61.8
	51.2	51.9	53.0	51.2	39.7	53.7	44.4	46.2
	50.2	54.0	45.4	45.7	46.4	55.9	50.3	38.4
	45.0	53.1	47.6	62.3	58.9	60.2	54.5	36.0
	57.1	64.0	48.4	61.8	42.6	44.8	58.7	43.2
	50.9	64.7	54.6	70.9	68.9	50.0	33.5	35.8
	49.6	45.9	49.8	41.3	53.7	50.4	54.7	
	43.6	50.0	54.7		57.3	43.3	50.7	
	36.4		55.8		63.4	35.9	21.0	
	38.2		59.4		60.8	32.2		
	53.9				59.8	50.0		
	51.7				50.5			
	45.4							
Sums	781.7	621.7	686.3	539.3	812.7	662.6	542.3	353.3
Means	48.8	56.5	52.8	53.9	54.2	47.3	45.2	39.2

Summary of Analysis of Variance

Source	df	MS	F	p
Between	7	3,427,935	4.15	<.01
Within	92	826,416		

[1] All factor scores were computed with a mean of 50 and a standard deviation of 10.

APPENDIX F3

Factor III Scores[1] for the Eight Age Groups

and Summary of Analysis of Variance

	16-20	21-25	26-30	31-35	36-45	46-55	56-65	66+
	62.4	53.8	48.9	51.8	61.6	48.4	49.4	41.3
	54.4	60.6	53.9	40.2	47.6	24.5	39.3	41.7
	64.3	61.6	44.3	60.4	53.9	47.5	30.4	30.2
	54.2	52.7	55.5	46.6	54.6	49.4	43.9	43.3
	60.1	59.4	57.6	55.7	54.5	48.9	42.3	39.1
	54.8	55.2	58.7	52.4	59.2	47.7	49.0	29.5
	62.7	55.5	57.8	49.8	37.2	36.8	30.0	30.2
	66.3	46.5	48.8	54.1	49.4	50.5	43.7	27.9
	58.0	41.6	50.7	39.0	46.9	48.9	33.2	42.4
	65.4	67.5	49.5	38.4	39.3	50.9	42.0	
	66.5	58.5	55.2		47.1	47.3	26.0	
	47.5		52.4		52.8	47.6	71.8	
	64.0		46.8		57.4	59.0		
	62.3				53.3	58.2		
	63.1				47.2			
	58.0							
Sums	964.0	612.9	680.2	488.4	762.0	665.8	501.1	325.5
Means	60.2	55.7	52.3	48.8	50.8	47.5	41.8	36.2

Summary of Analysis of Variance

Source	df	MS	F	p
Between	7	6,765,019	11.81	<.01
Within	92	572,848		

[1] All factor scores were computed with a mean of 50 and a standard deviation of 10

APPENDIX F4

Factor IV Scores[1] for the Eight Age Groups and Summary of Analysis of Variance

	16-20	21-25	26-30	31-35	36-45	46-55	56-65	66+
	48.6	51.2	41.2	39.9	51.0	47.2	54.3	45.8
	65.3	44.3	45.2	54.3	55.6	52.0	59.4	43.7
	49.9	67.3	47.1	49.2	44.2	64.3	65.0	36.5
	48.2	52.5	44.3	40.2	49.3	44.5	59.5	44.4
	60.3	44.3	47.0	44.5	53.4	50.7	55.5	56.5
	48.0	54.1	52.0	39.0	59.2	67.0	62.5	47.8
	46.3	45.3	39.5	46.7	49.2	43.1	36.7	74.9
	49.4	40.8	53.8	52.9	44.5	54.5	48.0	41.6
	36.6	57.4	40.0	60.1	60.5	72.5	29.0	44.6
	49.6	36.5	53.4	51.3	45.4	54.5	25.3	
	40.4	48.9	48.0		41.4	55.0	39.3	
	39.9		57.8		48.7	32.4	77.5	
	42.2		35.1		46.8	34.0		
	64.7				66.2	76.3		
	54.4				63.8			
	55.5							
Sums	799.3	542.6	604.6	478.3	779.3	748.2	611.9	435.8
Means	49.9	49.3	46.5	47.8	51.9	53.4	51.0	48.4

Summary of Analysis of Variance

Source	df	MS	F	p
Between	7	616,207	< 1	N.S.
Within	92	1,040,161		

[1] All factor scores were computed with a mean of 50 and a standard deviation of 10.

APPENDIX F5

Factor V Scores[1] for the Eight Age Groups

and Summary of Analysis of Variance

	16-20	21-25	26-30	31-35	36-45	46-55	56-65	66+
	44.3	55.9	58.8	39.2	41.1	51.8	46.6	52.5
	68.3	53.9	42.3	53.1	56.9	31.0	47.6	57.3
	24.0	57.2	27.5	43.8	37.9	42.8	72.2	39.6
	50,5	45.1	33.8	55.1	33.2	67.9	52.6	57.3
	42.8	43.6	51.5	54.8	56.0	29.4	67.0	46.4
	64.6	51.2	45.5	55.4	61.9	38.9	50.7	48.2
	35.8	48.4	62.4	64.5	49.8	35.2	55.3	56.4
	51.3	41.6	54.0	57.1	53.8	49.8	64.1	55.8
	50.4	46.9	41.4	53.1	44.4	70.6	44.5	25.0
	61.4	52.6	51.3	59.4	56.9	50.5	63.6	
	43.7	50.8	55.7		45.1	62.6	49.0	
	56.8		52.1		61.8	46.7	52.2	
	52.6		42.1		45.1	44.9		
	59.6				42.9	35.7		
	58.3				54.7			
	30.6							
Sums	795.4	547.3	618.4	535.6	741.6	657.8	665.3	438.5
Means	49.7	49.7	47.5	53.6	49.4	46.9	55.4	48.7

Summary of Analysis of Variance

Source	df	MS	F	p
Between	7	955,097	< 1	N.S.
Within	92	1,013,847		

[1]All factor scores were computed with a mean of 50 and a standard deviation of 10.

APPENDIX F6

Factor VI Scores[1] for the Eight Age Groups
and Summary of Analysis of Variance

	16-20	21-25	26-30	31-35	36-45	46-55	56-65	66+
	54.4	67.5	36.3	49.4	43.3	32.4	51.6	56.8
	52.3	32.2	60.8	76.7	48.9	42.8	43.0	31.0
	52.1	41.0	43.9	57.4	50.1	49.0	55.6	40.0
	43.7	64.1	34.2	55.2	53.1	49.0	55.9	52.6
	43.5	63.8	49.7	46.3	54.9	52.1	49.1	29.7
	61.8	48.6	43.4	58.0	46.0	38.0	22.3	51.1
	50.4	58.3	52.5	63.0	56.8	46.3	39.8	56.4
	32.5	53.6	42.4	52.1	65.8	51.9	36.2	62.8
	62.2	59.7	55.7	43.6	50.9	41.1	54.1	62.2
	48.7	31.0	60.5	54.8	50.4	48.7	50.4	
	44.3	56.5	44.6		43.5	55.2	61.7	
	58.4		25.3		52.4	46.8	74.9	
	48.0		61.4		59.7	55.4		
	58.0				51.1	44.4		
	50.5				35.9			
	42.8							
Sums	803.5	576.4	610.3	556.5	762.8	653.1	594.8	442.5
Means	50.2	52.4	46.9	55.6	50.8	46.6	49.6	49.2

Summary of Analysis of Variance

Source	df	MS	F	p
Between	7	916,549	< 1	N.S.
Within	92	1,020,692		

[1] All factor scores were computed with a mean of 50 and a standard deviation of 10.

APPENDIX F7

Factor VII Scores[1] for the Eight Age Groups

and Summary of Analysis of Variance

	16-20	21-25	26-30	31-35	36-45	46-55	56-65	66+
	50.7	55.3	49.5	29.3	51.3	63.9	34.5	61.7
	57.6	66.8	47.2	59.1	53.2	69.3	56.3	49.5
	51.7	59.0	42.0	43.6	45.5	52.9	58.6	55.4
	51.5	56.0	70.4	57.3	54.6	63.5	42.2	22.2
	64.0	40.4	37.2	47.8	51.3	43.9	61.4	49.5
	42.8	64.2	55.5	40.7	38.6	26.0	40.9	45.9
	48.3	40.5	54.0	48.9	53.9	53.4	43.5	46.3
	53.0	49.3	55.0	53.3	57.3	40.0	37.4	42.8
	40.6	46.4	65.3	50.6	59.5	26.9	40.0	32.3
	45.1	52.1	53.3	60.3	60.2	63.1	47.2	
	56.5	52.1	54.9		43.6	50.4	49.0	
	34.6		48.7		39.0	71.3	62.6	
	42.0		62.0		49.2	57.5		
	42.4				30.5	57.4		
	47.1				58.2			
	38.5							
Sums	766.4	582.2	695.1	490.9	746.6	739.5	573.5	405.7
Means	47.9	52.9	53.5	49.1	50.0	52.8	47.8	45.1

Summary of Analysis of Variance

Source	df	MS	F	p
Between	7	970,854	< 1	N.S.
Within	92	1,016,015		

[1]All factor scores were computed with a mean of 50 and a standard deviation of 10.

APPENDIX F8

Factor VIII Scores[1] for the Eight Age Groups

and Summary of Analysis of Variance

	16-20	21-25	26-30	31-35	36-45	46-55	56-65	66+
	63.9	68.8	55.4	47.5	43.3	61.0	52.4	54.4
	51.4	44.1	58.2	47.9	38.6	56.3	78.4	65.3
	71.5	38.5	48.0	65.0	62.4	51.2	32.7	51.5
	50.2	60.4	53.0	49.2	43.3	41.0	54.0	48.3
	42.8	46.8	49.0	31.8	49.0	39.9	45.1	58.0
	57.4	50.7	44.9	32.8	54.5	55.8	18.8	49.9
	37.0	39.4	41.6	38.6	40.1	57.4	52.3	58.4
	71.0	56.0	44.2	46.4	42.8	62.5	59.7	51.2
	66.6	43.0	43.0	37.1	52.2	55.8	54.6	39.1
	39.8	48.7	37.9	45.5	46.2	46.4	49.6	
	53.6	57.4	58.9		38.2	48.7	50.4	
	28.5		49.2		47.3	61.1	50.4	
	41.3		41.7		58.3	50.0		
	72.6				47.6	52.1		
	41.1				60.8			
	51.9							
Sums	840.9	553.7	625.0	441.7	724.6	739.3	598.6	476.1
Means	52.6	50.3	48.1	44.2	48.3	52.8	49.9	52.9

Summary of Analysis of Variance

Source	df	MS	F	p
Between	7	965,863	< 1	N.S.
Within	92	1,016,225		

[1]All factor scores were computed with a mean of 50 and a standard deviation of 10.

APPENDIX F9

Factor IX Scores[1] for the Eight Age Groups

and Summary of Analysis of Variance

	16-20	21-25	26-30	31-35	36-45	46-55	56-65	66+
	50.0	48.1	54.0	46.6	50.3	64.6	50.7	46.4
	51.5	46.0	42.7	49.9	53.7	83.5	72.5	46.6
	46.2	57.8	72.9	42.8	51.8	59.1	72.8	48.3
	54.1	62.3	46.8	47.6	44.1	63.3	35.4	49.4
	60.5	63.0	66.0	58.9	47.4	52.9	42.5	51.2
	49.5	52.8	54.5	51.2	63.0	50.2	25.9	35.4
	51.6	43.2	65.9	49.1	40.1	40.2	49.3	50.6
	52.3	42.6	41.3	43.3	47.4	47.9	55.1	43.4
	73.5	55.9	40.6	53.2	39.2	57.1	42.0	49.5
	53.1	38.9	56.3	46.0	37.4	56.8	39.9	
	55.8	34.0	34.9		43.9	62.1	37.8	
	55.3		46.2		73.0	40.0	41.0	
	42.6		43.6		36.4	55.9		
	43.0				45.9	40.2		
	41.7				48.0			
	38.2							
Sums	818.9	544.8	665.8	488.8	721.8	774.0	564.8	420.9
Means	51.2	49.5	51.2	48.9	48.1	55.3	47.1	46.8

Summary of Analysis of Variance

Source	df	MS	F	p
Between	7	937,527	< 1	N.S.
Within	92	1,018,956		

[1]All factor scores were computed with a mean of 50 and a standard deviation of 10.

APPENDIX F10

Factor X Scores[1] for the Eight Age Groups

and Summary of Analysis of Variance

	16-20	21-25	26-30	31-35	36-45	46-55	56-65	66+
	58.4	59.1	53.0	58.6	46.6	54.9	50.7	48.9
	84.2	62.1	49.6	57.4	52.7	59.8	60.4	49.0
	44.4	40.6	36.5	45.2	33.7	49.0	55.0	42.5
	47.4	46.1	36.8	51.5	69.1	47.7	60.0	37.8
	33.7	41.9	62.8	47.0	50.1	38.4	46.1	44.6
	51.2	46.3	47.3	50.9	51.0	31.7	45.9	49.1
	43.9	40.0	36.9	46.3	37.4	47.7	46.2	62.2
	66.7	44.8	44.8	55.4	55.0	51.2	43.3	57.8
	49.1	45.8	51.1	44.4	44.7	44.2	45.4	48.5
	39.8	51.2	57.7	45.1	64.4	46.2	44.0	
	60.2	49.5	51.6		56.5	33.1	53.0	
	93.0		47.1		57.5	49.9	40.8	
	63.2		43.0		39.0	40.4		
	60.3				47.1	49.8		
	44.6				52.6			
	79.0							
Sums	919.1	527.4	618.3	488.7	757.5	644.1	590.9	440.5
Means	57.4	48.0	47.6	48.9	50.5	46.0	49.2	48.9

Summary of Analysis of Variance

Source	df	MS	F	p
Between	7	1,740,017	1.82	N.S.
Within	92	957,411		

[1]All factor scores were computed with a mean of 50 and a standard deviation of 10.

APPENDIX F11

Factor XI Scores[1] for the Eight Age Groups

and Summary of Analysis of Variance

	16-20	21-25	26-30	31-35	36-45	46-55	56-65	66+
	51.9	47.4	36.6	53.0	50.9	51.2	40.3	35.0
	51.8	48.0	42.1	41.1	32.2	32.5	60.3	49.1
	44.0	67.4	61.8	55.5	58.7	56.5	33.8	43.2
	54.5	45.5	51.9	47.7	37.7	50.2	46.5	53.1
	49.3	42.7	53.5	50.1	44.4	50.3	58.7	39.9
	45.6	45.0	50.9	48.3	51.8	54.4	47.7	40.8
	67.4	68.2	43.0	68.4	42.2	54.2	43.0	71.3
	49.0	49.3	56.5	38.6	60.9	43.0	44.2	58.0
	48.9	44.2	53.1	50.2	44.4	46.6	43.7	55.7
	63.8	47.5	53.5	65.1	67.6	44.5	46.5	
	49.1	55.3	57.7		42.5	66.2	33.4	
	62.7		77.7		18.5	27.0	39.0	
	58.7		50.9		35.2	63.4		
	52.2				45.8	60.1		
	61.5				48.8			
	56.2							
Sums	866.6	560.5	689.3	518.0	681.9	700.3	537.3	446.1
Means	54.2	51.0	53.0	51.8	45.4	50.0	44.8	49.6

Summary of Analysis of Variance

Source	df	MS	F	p
Between	7	1,470,802	1.50	N.S.
Within	92	978,172		

[1]All factor scores were computed with a mean of 50 and a standard deviation of 10.

APPENDIX F12

Factor XII Scores[1] for the Eight Age Groups and Summary of Analysis of Variance

	16-20	21-25	26-30	31-35	36-45	46-55	56-65	66+
	38.6	51.3	47.8	52.4	55.0	52.8	71.7	67.3
	50.9	49.0	54.7	60.6	48.6	57.9	41.9	65.6
	51.6	53.1	58.3	53.9	28.6	52.0	55.7	53.8
	48.3	53.2	57.1	71.8	59.4	57.2	54.1	27.9
	49.0	53.5	63.1	58.2	51.6	49.6	55.0	40.1
	49.2	55.8	46.2	63.8	50.2	59.7	43.7	47.7
	45.2	47.2	57.3	64.7	39.8	43.8	52.0	38.3
	48.9	10.4	60.2	36.2	53.5	51.6	66.2	41.1
	48.1	44.7	55.7	45.4	55.8	52.7	57.6	48.6
	49.3	33.2	46.4	56.0	47.6	48.3	44.5	
	40.8	62.2	40.6		40.6	57.5	37.1	
	37.0		41.0		45.7	37.0	24.7	
	50.8		29.9		57.2	39.8		
	49.0				61.9	56.5		
	48.0				61.2			
	53.3							
Sums	758.3	513.6	657.3	563.0	756.7	715.6	604.3	430.5
Means	47.4	46.7	50.6	56.3	50.4	51.1	50.4	47.8

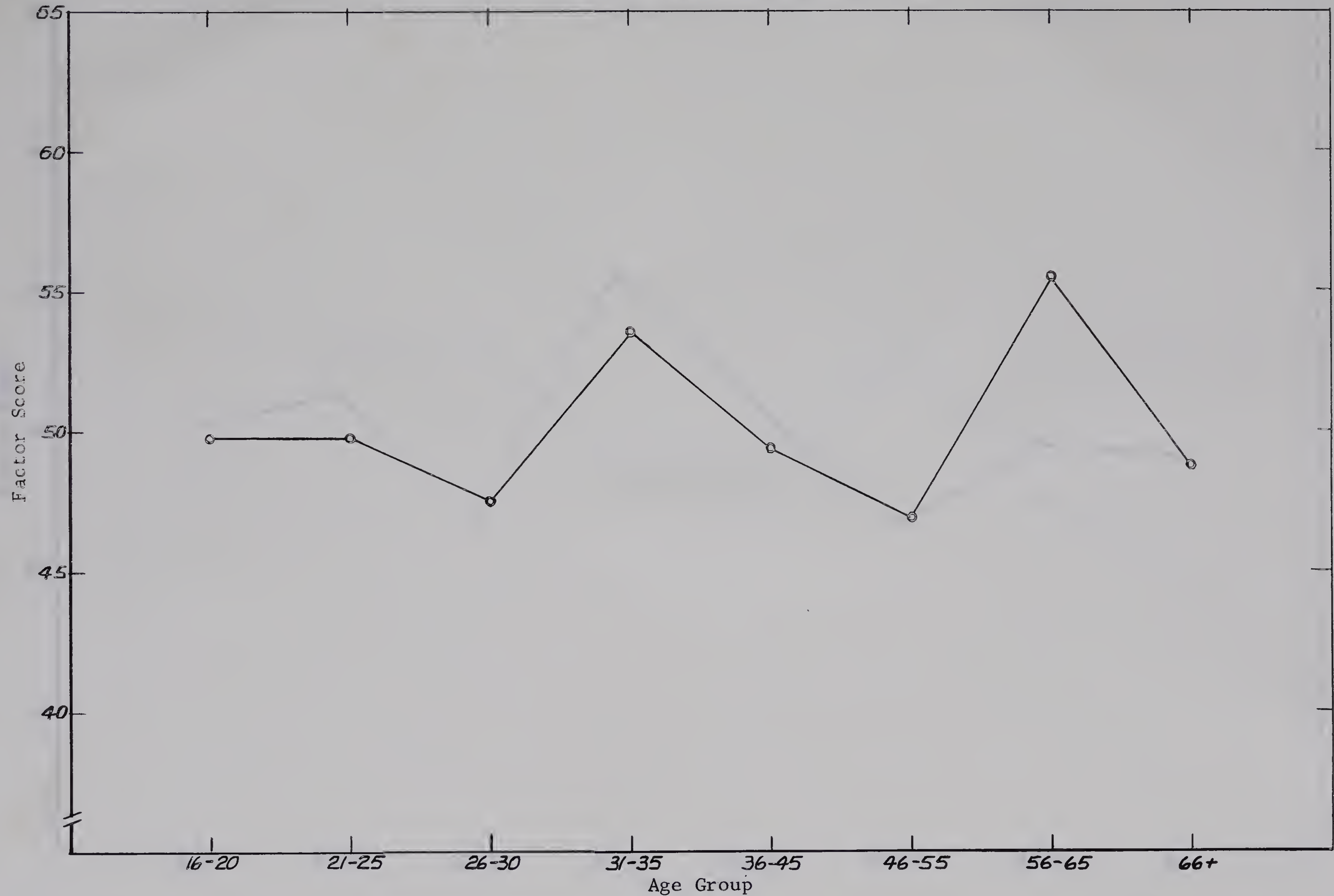
Summary of Analysis of Variance

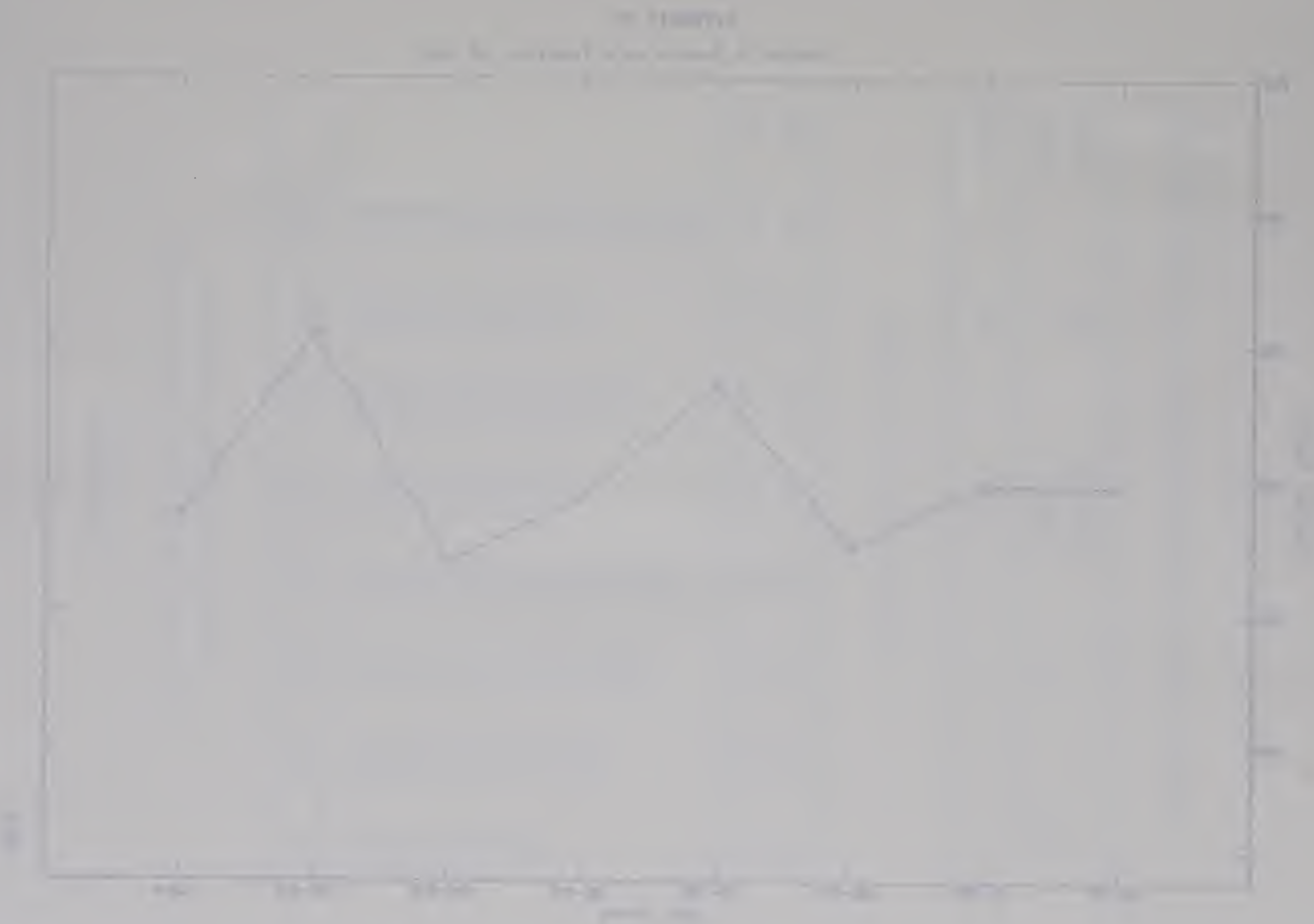
Source	df	MS	F	p
Between	7	938,273	< 1	N.S.
Within	92	1,013,956		

[1] All factor scores were computed with a mean of 50 and a standard deviation of 10.

APPENDIX G1

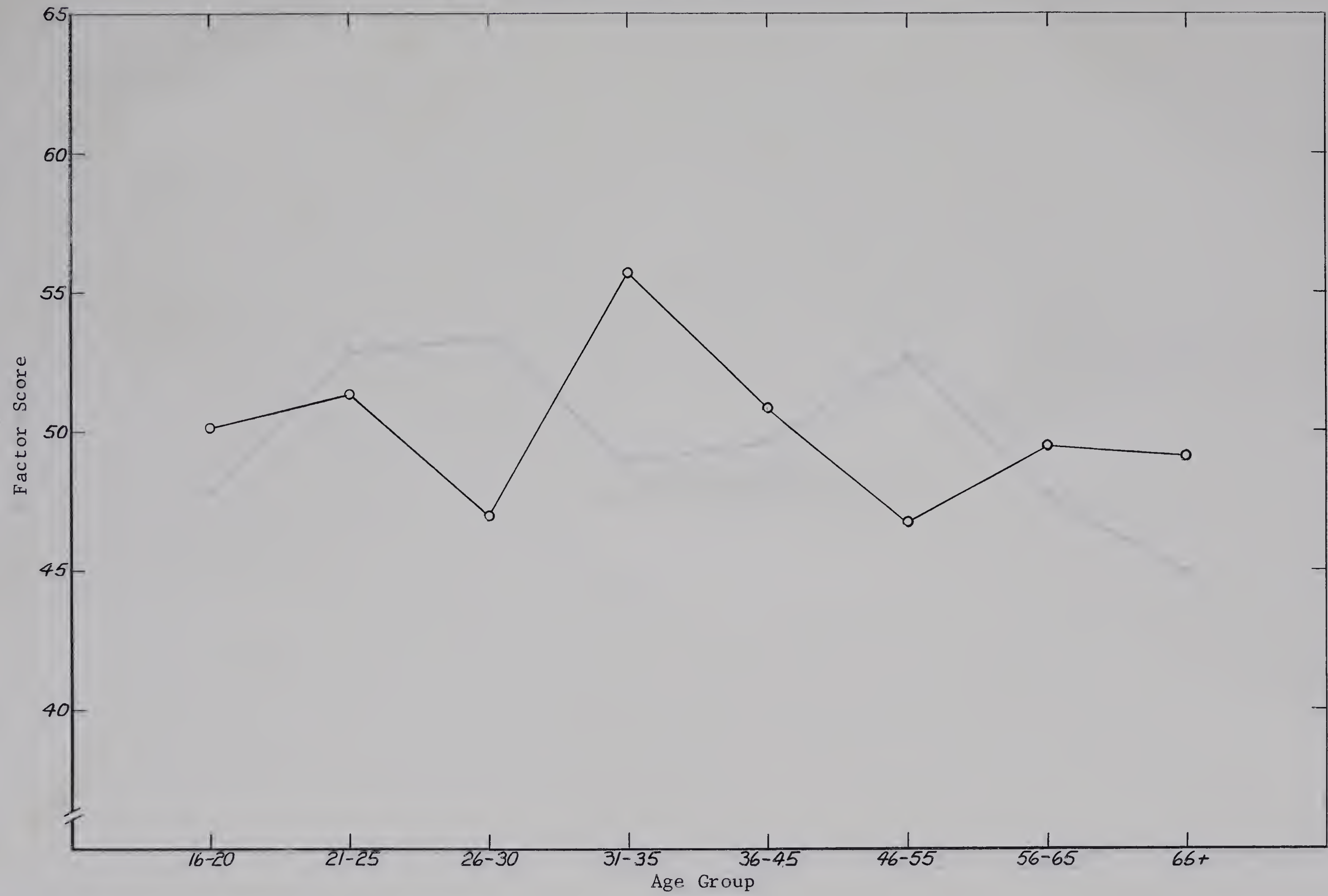
Factor V Scores as a Function of Age





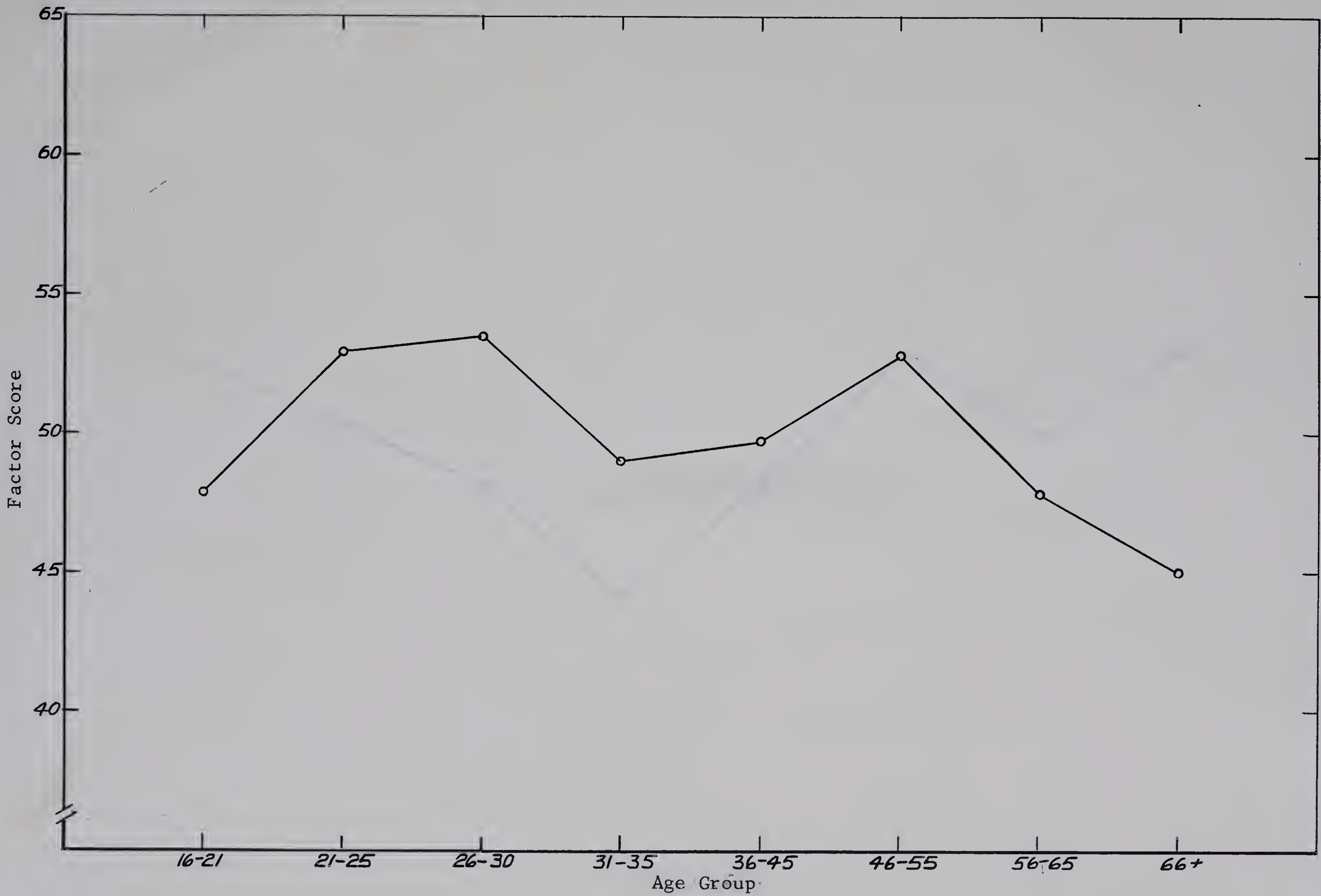
APPENDIX G2

Factor VI Scores as a Function of Age



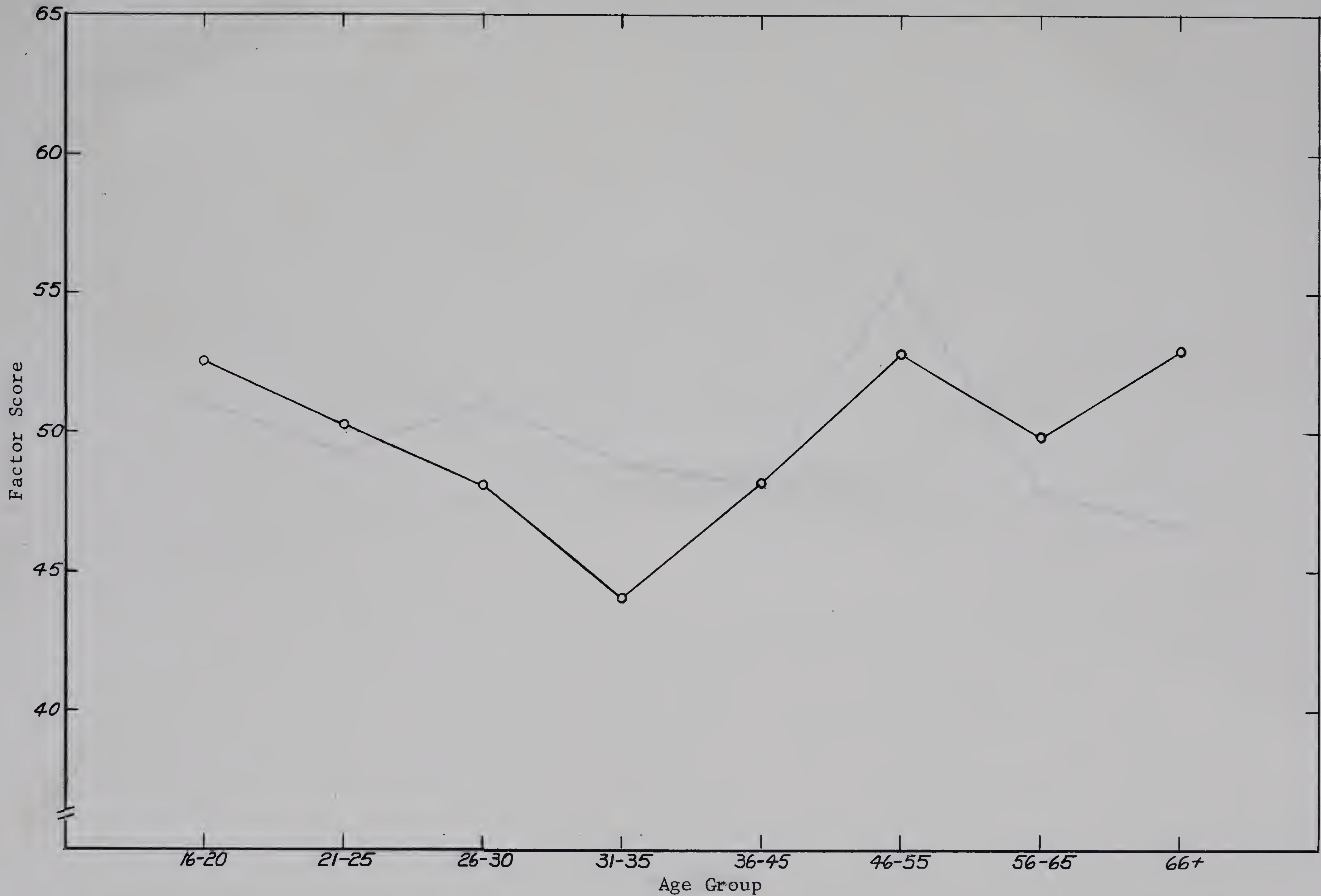
APPENDIX G3

Factor VII Scores as a Function of Age



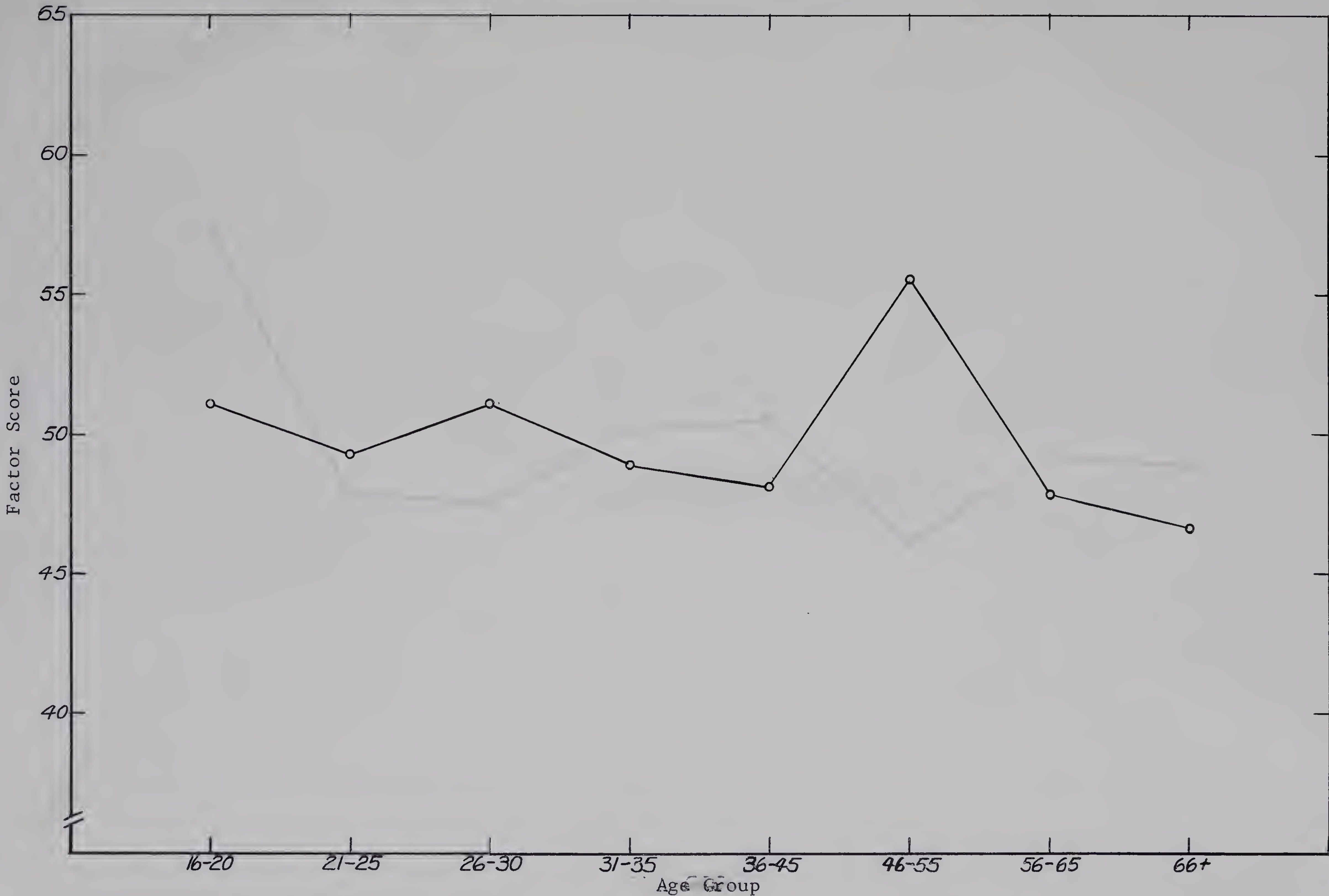
APPENDIX G4

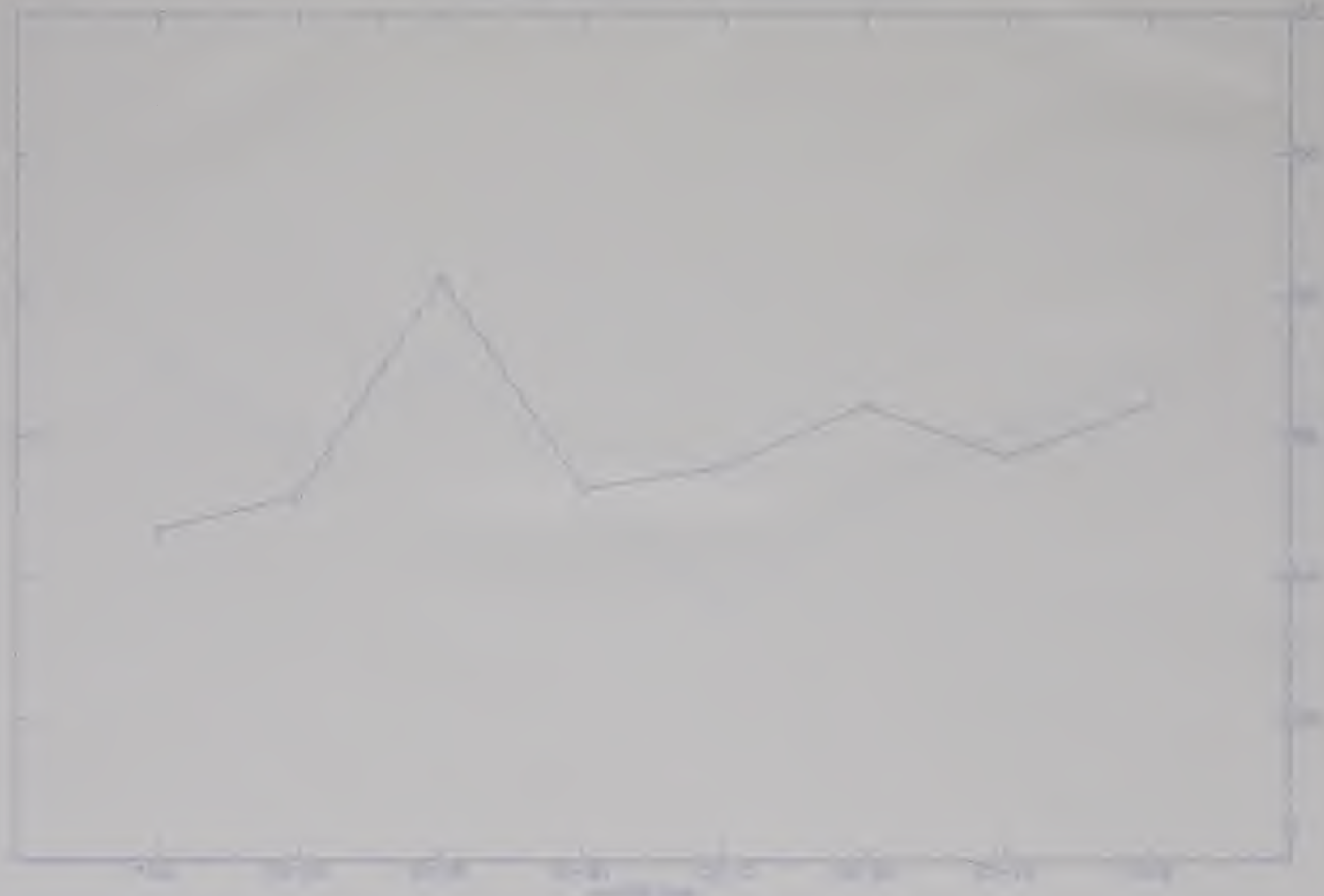
Factor VIII Scores as a Function of Age



APPENDIX G5

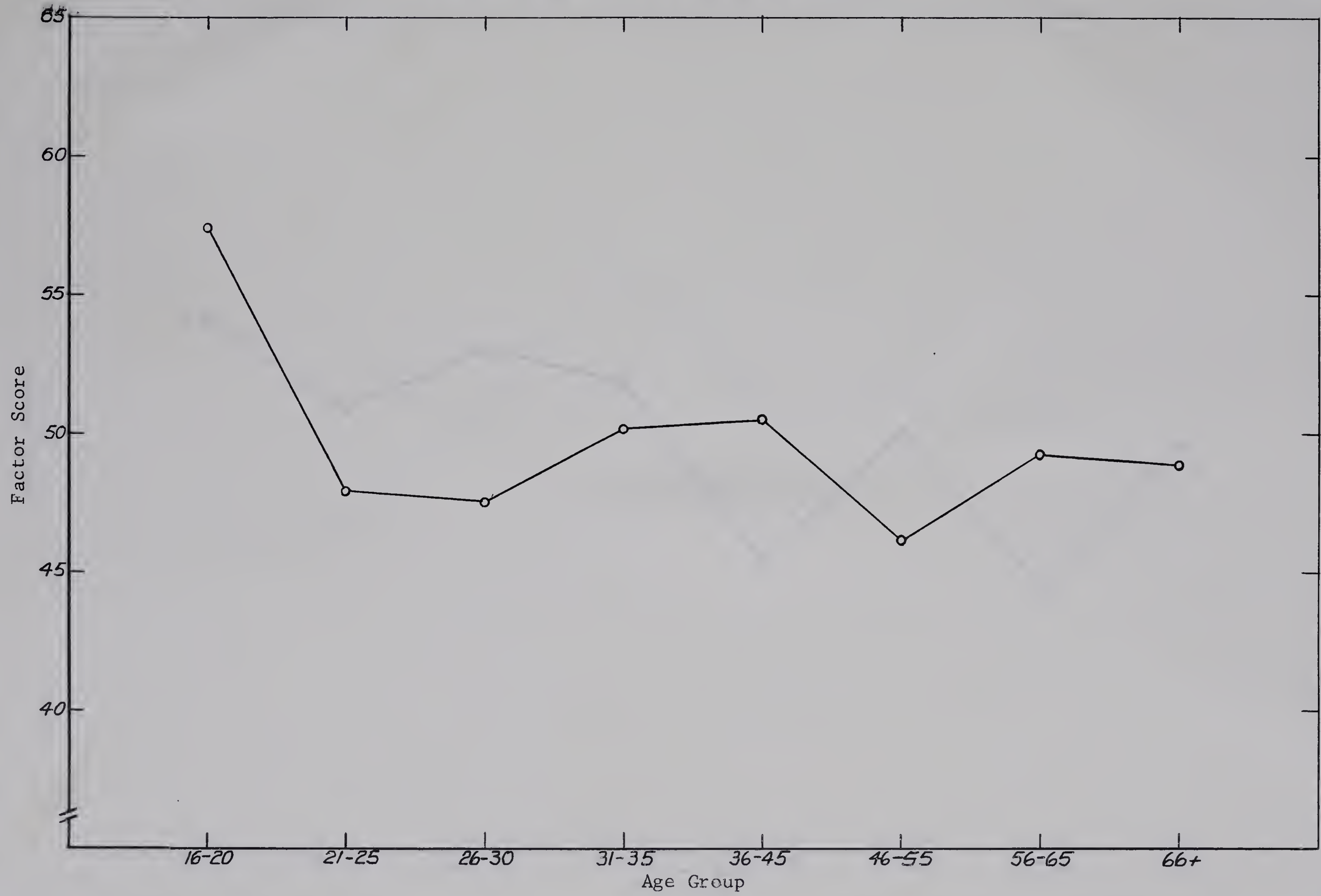
Factor IX Scores as a Function of Age





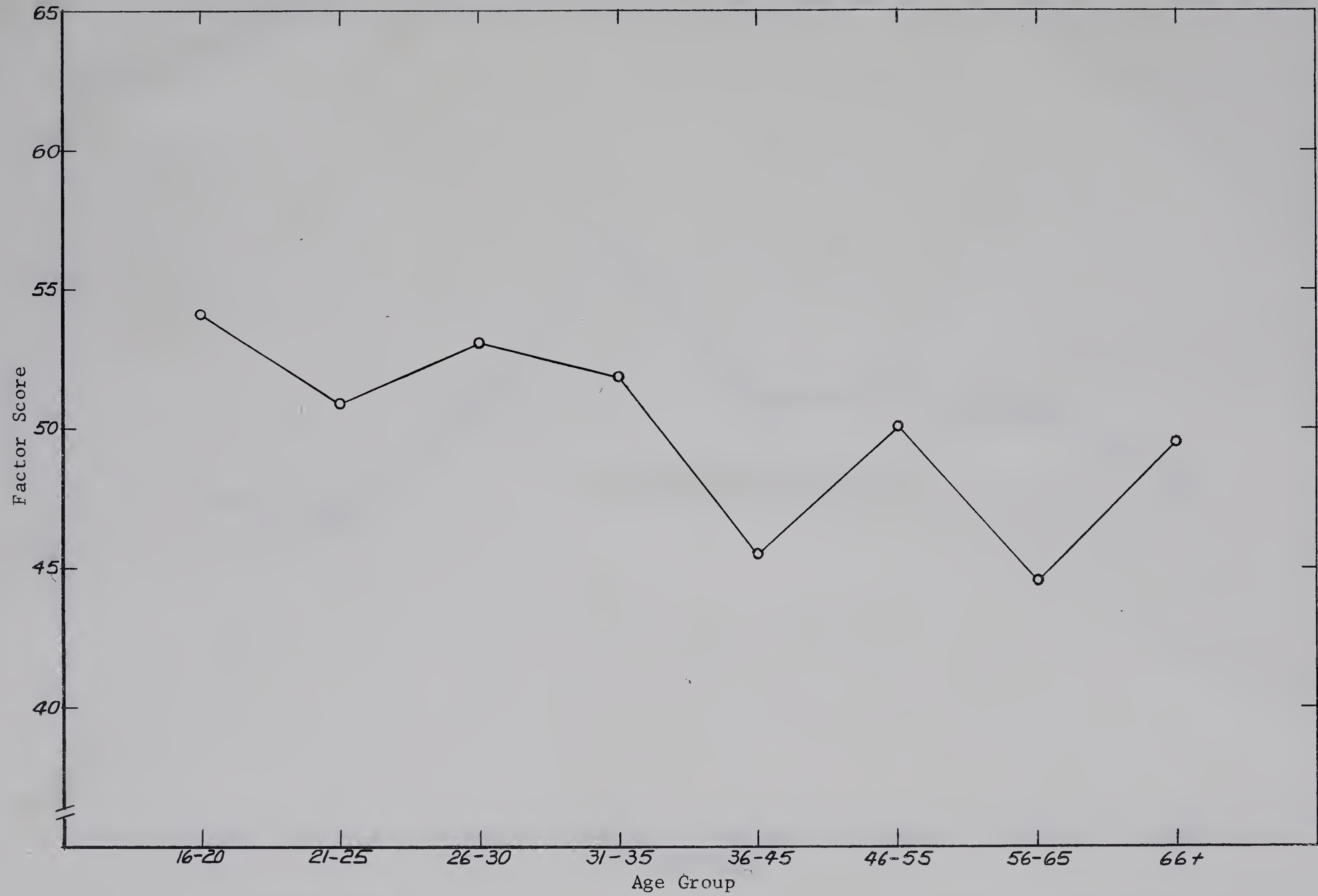
APPENDIX G6

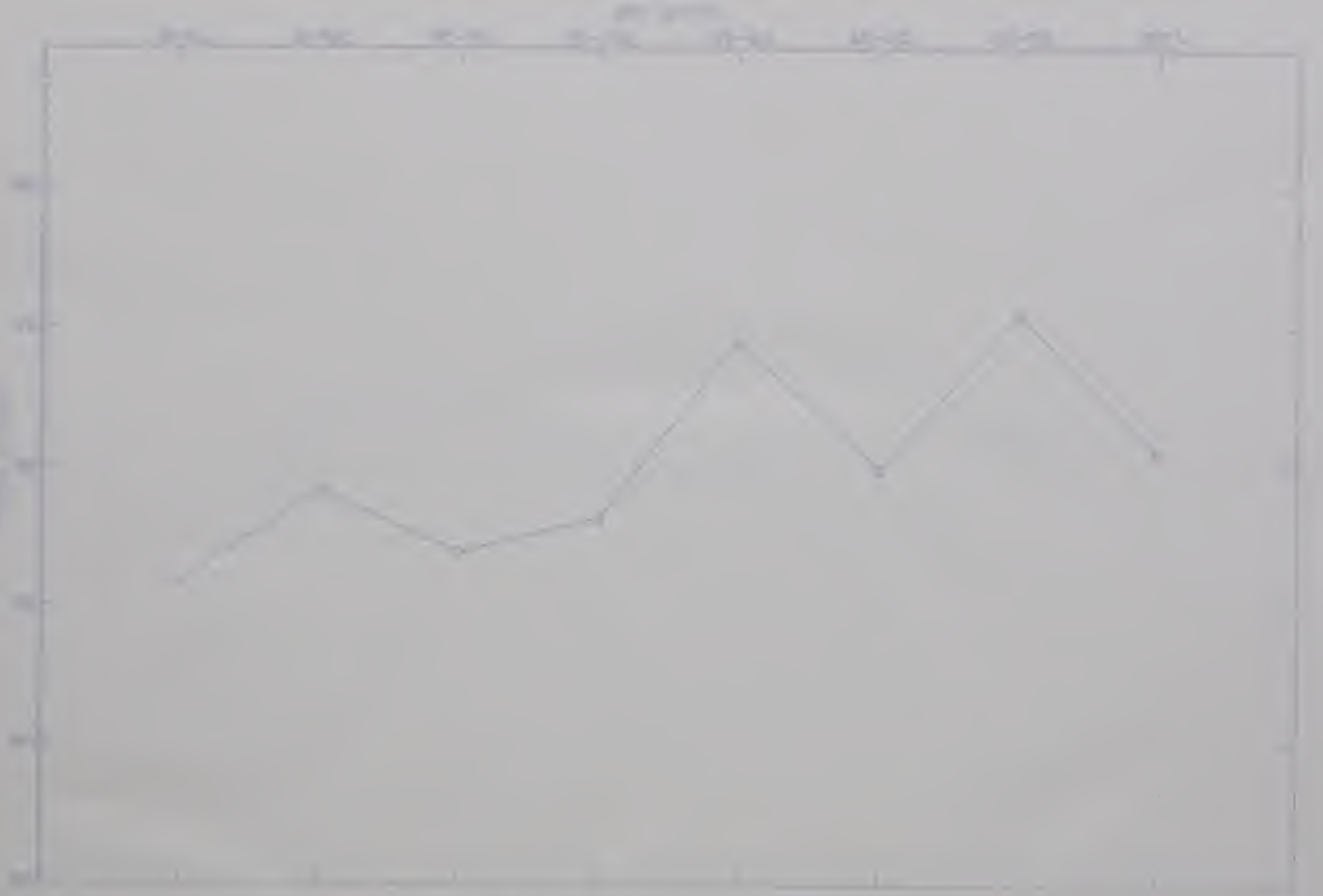
Factor X Scores as a Function of Age



APPENDIX G7

Factor XI Scores as a Function of Age





APPENDIX G8

Factor XII Scores as a Function of Age